DAIRY FARMING IN THE EIGHTIES

In spring the dairy herd is turned out to grass. It is something of an occasion as the cows canter off for their first taste of fresh grass for several months. For the rest of the year the farmer works hard to provide the right food for a high milk yield.

Cattle spend most of their lives eating. They are equipped with large capacity complex digestive systems geared to process enormous quantities of bulky, low-value green food, break down the cellulose which renders it indigestible to most other animals (including humans), and convert it into energy, meat and milk.

Right: Most dairymen grow two or three fields of barley, for it is excellent cattle feed.

Below: Friesian calves–one of the most popular dairy breeds of cattle, with a good milk yield.

Counting the cost Much of the dairy farmer's year is spent providing for this prodigious appetite, ensuring that each cow has enough to maintain her in good health and keep the milk flowing. Maintenance presents few problems, but catering for the high production rates expected of the modern dairy herd from the limited acreage of the average farm requires meticulous planning, careful husbandry, and a keen appreciation of economics. Farm-produced crops may account for the bulk of the herd's requirements but concentrated, high-value feedstuffs such as vitamin-enriched sugar beet pulp, purchased by the sackload, are an essential supplement to the diet. The farmer must weigh the cost of these against the extra yield they represent, decide on a feeding strategy and adjust his planning accordingly.

Some dairymen aim for record milk yields, boosting each cow's performance by feeding quantities of high value concentrates and limiting access to bulky, low value forage. Others take the opposite view, attempting to feed the herd almost exclusively on farm produce, and accepting lower yields in return for reduced overheads. The majority of dairy farmers compromise, use bought-in feedstuffs in moderation, and employ the farm's resources to provide a steady, balanced diet throughout the year.

Above: A silage clamp being opened up in winter for food. In summer (below) cattle are often restricted to one day's hard grazing by subdividing the field with portable electric fencing.

Grass The most important resource available to the milk producer is grass. Over three-quarters of the land on a dairy farm is allocated to grass of some description. It grows well in the British climate, it is the cow's natural food, and it has the immense advantage of being resistant to cutting and grazing. Most farm crops are finished once they are harvested, but grassland crops (a category which includes clover and lucerne as well as grass) sprout new shoots and grow with renewed vigour.

Grass is at its best during the spring flush in May and June. The cattle are turned out for the first bite at the beginning of this period, and for a few weeks the grass provides nearly all the food they need. The farm is divided into areas calculated to give a day's grazing each. Normally these areas are the traditional hedged or walled fields which were originally laid out for the purpose, but often it is convenient to subdivide one field using portable electric fencing. By intensively stocking one field at a time the cattle are encouraged to make the most of the grass, and not pick and choose the juiciest morsels. Each day the herd is moved on to fresh pasture, and the grass in the vacated field is allowed to recover. By the time the herd has eaten its way right round the farm there is new grass in the first field, and any remaining disease organisms or parasites are dead.

Milking The cows are brought in for milking twice daily. At one time this was carried out in the fields, in the yard or the cowshed, by hand or with a portable milking machine. Today each dairy farm has a purpose-built milking parlour incorporating a number of stalls. Each is equipped with a vacuum milking apparatus connected to a large glass jar, enabling the herdsman to monitor each cow's output. The jars are linked in turn to cooling equipment and a bulk

tank which is emptied daily by the road tanker.

As the cows enter the parlour they are secured in the stalls and placated with a ration of the high value concentrated food used to supplement the bulk forage. The herdsman washes down each cow, examines her for injury, illness and general condition, then attaches the cups of the milking machine. When the last drops have been drawn into the jar the amount is noted, the cow released and her place taken by another animal.

Each cow will give between eight and twenty litres of milk a day, averaged over the year, depending on the breed and the level of feeding. The yield is at its peak a few weeks after calving, which is usually arranged for the autumn; after this it declines steadily, apart from a rise in output during the spring flush, until at some point in the summer it dries up completely. The dry cow is then given a rest for two months before calving again. The herd is divided up so that there are always some cows in milk; these get the pick of the pasture, and it is common for the dry cows to follow the main herd round the farm, finishing up the leftovers.

Preparing for winter While the cattle are catering for themselves on the pasture, the farmer is preparing for the following winter by harvesting some of the spring grass and preserving it in the form of hay or silage. A number of fields are set aside for the grass to grow long and succulent, before it is cut with a mower. Then it may be dried in the sun and baled as hay, or picked up and chopped by a forage harvester ready for silage-making. This involves emptying the chopped grass into a walled silo or clamp, compressing it to exclude air, and covering it with plastic sheeting. An alternative is simply to roll the green grass into a big round bale and put it into a plastic bag. Either way the grass is preserved by fermentation in an airtight container; in the British Isles the technique has largely superseded haymaking as it relies less on good weather.

Above: Milking time, and the cows make their way to the milking parlour. Each cow will give between 8 and 20 litres of milk daily.

Right: Calves feeding. Initially they are fed on their mother's first milk which contains vitamins and antibodies, but in a few days the cows join the dairy herd and the calves are switched to milk substitutes and then solid foods.

Once the grass has recovered after mowing it can be used as pasture or grown on for a second silage cut in the autumn. A good store of silage or hay is essential for the productivity of the herd, for the grass stops growing over winter and grazing is impossible.

As the last of the hay is baled in July the farmer prepares to harvest the barley. Most dairymen grow two or three fields of barley; it has a high carbohydrate content which balances the protein-rich grass. The crop is cut with a combine harvester which separates the grain from the straw and chaff; the straw is usually baled for use as litter, although it can be chemically treated to make a useful substitute for hay. The grain is stored in sealed silos to prevent it going mouldy, and drawn on as required throughout the year.

The dairy farmer is well placed to produce a good barley crop (or indeed a cash crop of

Crop rotation

The temporary grassland on the dairy farm is shown here in the three blocks: newly sown grass, well-established grass and old grass due for renovation. Each block stays down for three to twelve years, depending how well its quality is preserved. (Grass which is left for longer is permanent pasture.) It is then ploughed up and the land is used for barley, wheat or maize (for example) for a few seasons before reseeding with grass.

Grass

- newly sown
- well-established
- old–due for renovation

Above: A modern dairy farm has a milking parlour that is computer controlled. The cows enter the stalls, are then checked and washed down, and the cups of the milking machine attached. The animals meanwhile are placated by mineral and vitamin-rich concentrated feed. Their yield is recorded and then stored before it is collected each day by the milk tanker.

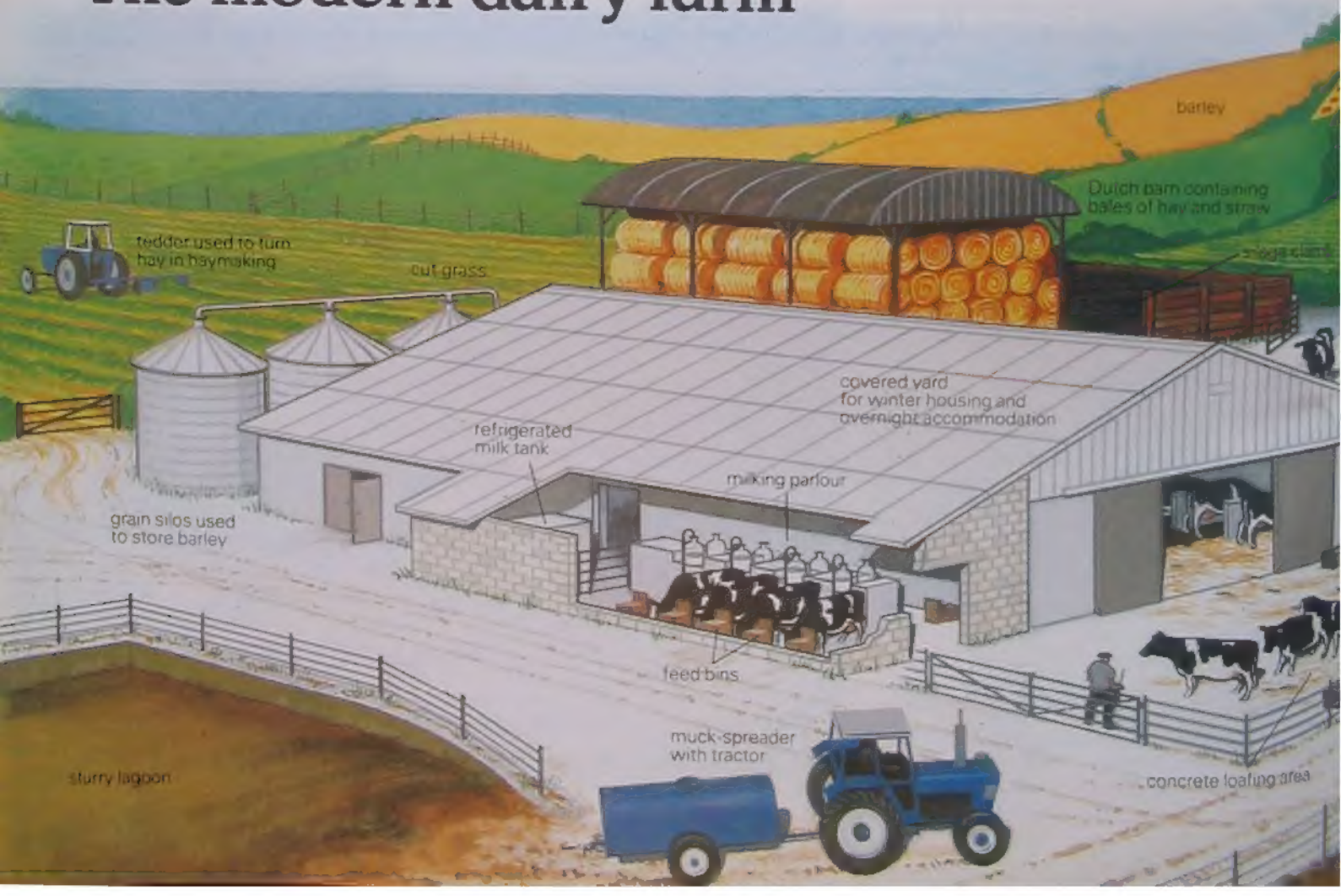
wheat if the price is right), having at his disposal plenty of well-manured grassland which can be put under the plough. The arable farmer, establishing consecutive grain crops on the same land, has to deal with weed and disease build-up and infertility problems, but the dairyman can avoid all this merely by ploughing up a different area of pasture each year. Consequently the barley moves round the farm in the same way as the dairy herd at pasture, if somewhat less rapidly. The same applies to the crop of maize which is often grown, in the south at least, to supplement the winter food ration. Harvested in the autumn, it is chopped up for silage in the same way as grass.

By the time the pasture is due for ploughing up its quality will have deteriorated due to the invasion of various wild grasses and herbs. Some of these are relished by cattle, but most contribute little to productivity and some, such as field buttercup and Oxford ragwort, are poisonous. Using the land to grow a crop of barley provides an opportunity to start afresh with new seed after the grain harvest. The most commonly planted species are Italian and perennial ryegrass. These are sometimes combined with meadow fescue, timothy or cocksfoot, the latter being a deep-rooted, drought-resistant species. White clover is a popular ingredient of the mix; it is rich in protein, improves the fertility of the land, and strengthens the turf with its creeping stems.

The strongest turf of all is permanent pasture, and on land which is easily waterlogged there is much to be said for leaving the grass as it is, maintaining the quality by a strict regime of grazing and cutting. Most dairy farms have a little permanent pasture, but in some areas nearly all the grassland is permanent, and arable cropping is restricted to a small fraction of the acreage.

Autumn calving By early autumn many of the cows are ready for calving. A cow has to bear a calf before she will give milk, and dairy

The modern dairy farm



farmers often mate a beef-type bull with their cows to produce crossbred calves. The advantage of this is that all the calves can be sold for beef to earn a predictable return. The most popular bull for this purpose is probably the Hereford, a stocky brown animal with a white face. This facial characteristic is inherited by the calves, together with a capacity for doing well off second-rate pasture; more fashionable crosses with, for example, Charolais or Limousin bulls have tremendous beef potential, but require better feeding to realise it.

Another way is to breed replacement milkers using a dairy bull. The farmer is spared the expense and risk of buying in young cows of possibly indifferent performance, and has the satisfaction of making his own breeding decisions, but he then has the problem of surplus male calves. One reason for the popularity of the black and white British Friesian is the tolerable beef quality of unwanted stock; most dairy cattle of no milking value fetch a poor price at market.

Young calves are taken away and raised by hand soon after they are born. By degrees they are accustomed to solid foods until eventually they are weaned on to the spring grass. Beef calves are either sold at this stage if grazing is short, or kept on grass through the summer and sold as well-grown 'store cattle' in the autumn.

In late autumn the grass stops growing, and as the weather becomes colder and wetter the precious turf is easily trampled into a muddy waste. To prevent this the herd is taken off the pasture for the winter and fed on the hay and silage which was made earlier in the year. Some farmers grow a variety of supplementary forage crops such as kale, cabbage and turnips; these produce a good head of foliage during the winter months and may be grazed off strip by strip under the control of an electric fence. High-yielding herds are normally housed throughout the winter in covered yards, and live exclusively on preserved foodstuffs until they are liberated on to the new grass the following spring. After a winter in the cattle yards they push their way through the open field gate, kick up their heels and canter off across the crisp new pasture in search of fresh food.

Left: Bull talk. The most popular bull is probably the Hereford. This and other beef-type breeds, such as Charolais, Aberdeen Angus and Limousin, are often mated with dairy cows so that all the calves can be sold for beef, regardless of their sex. Alternatively a bull of the same breed can be used: although it will produce a number of females which can join the milking herd, there will also be some surplus bull calves which will probably be of little value.
Within a few weeks of calving the cow is mated again. For crossbred calves, or dairy calves of minority breeds, a bull is usually kept on the farm and run with the herd. The alternative is to use artificial insemination, courtesy of a high-performance pedigree bull kept on a stud farm. Herd quality can be greatly improved this way, at a price, but the choice of bulls is very limited with any but the most popular breeds.

DYERS' PLANTS: NATURE'S COLOURS

This country has a long history of using the juices of plants to dye wool and cloth, the dyes being made from plant leaves, stems, roots and even, as with saffron, from the stigmas. Whole crops were often grown exclusively to supply the dyers' trade.

Right: Also known as dyer's rocket, weld (*Reseda luteola*) is a native plant which grows on arable land and waste places. Used for dyeing, it yields a very pure, bright yellow.

The art of dyeing is believed to have been practised in China as long ago as 3000BC, and an enormous range of different plants have been used for the purpose. In Britain a number of native plants yielded suitable dyes, but some others were specially imported and grown as well.

The saffron crocus This plant is not native to Britain but it was cultivated here at one time for the deep orange dye that could be obtained from the stigmas of its flowers. It is now no longer grown in this country, but records of its cultivation as a dye plant date back to the 14th century. The saffron grown in the Essex and Cambridgeshire areas was deemed to be of the best quality and the town of Saffron Walden, previously called Chipping Walden, takes the first part of its name from the crocus which provided an important local income. However, during the 18th century there was an influx of foreign saffron into the country which, although of poorer quality, was much cheaper. As a consequence the growing of saffron in England gradually declined and the last record of it being grown commercially was in 1816.

The saffron crocus, a member of the Iridaceae family, flowers in the autumn from September to November. It grows from a small corm and produces several narrow leaves and a pale purple flower with six petals. The three-lobed stigma in the centre of the flower is a bright orange-red and it is from this that the dye is produced. It takes over 4000 flowers of the saffron crocus to produce just a single ounce of the finished product.

Blue dye from woad In Britain during the Middle Ages the poorer people wore garments of black, brown, grey or white–the natural colours of wool–but the more well-to-do folk wore clothes that were coloured. The most fashionable colour was the blue obtained from the woad plant, partly because it did not fade when subjected to bright sunlight or water, as some other dyes were prone to do. For a long time woad was unrivalled as a blue dye and consequently cultivated extensively, both in Britain and other countries of Europe.

Woad is a member of the cabbage family (Cruciferae) and, like the saffron crocus, was

Opposite right: A selection of natural-dyed wool. The top right-hand ball has been dyed with woad; weld was used for the bright yellow ball halfway down, and next to it is an orange ball dyed with madder.

Below: The pale purple flowers of saffron crocus (*Crocus sativus*). Centuries ago it was cultivated in Britain for the dye that can be extracted from the bright orange, three-lobed stigmas in the centre of each flower.

Above: A greenish-yellow dye can be obtained from dyer's greenweed (*Genista tinctoria*), a member of the pea family. In conjunction with woad, it gives a colour known as Kendal green, after the Cumbrian town where it was first developed.

Left: Despite the vivid yellow of its flowers, woad (*Isatis tinctoria*) yields a blue dye. This is extracted from its leaves, which give little indication of their potential, being only slightly bluish in colour.

introduced into this country for use as a dye plant. It is a biennial or perennial herb with an erect stem 50-120cm (20-50in) high. The upper part of the stem is branched and bears four-petalled yellow flowers during July and August. The pendulous fruits are flattened, with a broad wing. However, it is neither the flowers nor the fruits which yield the famous blue dye, but the leaves, though they give little indication of their potential, being only slightly bluish-green.

Somerset and Lincolnshire were particularly noted as woad growing areas and in Somerset it used to be one of the main agricultural products.

Yellows, reds and purples When different colours were required, woad was used in conjunction with other dyes. For instance, to obtain green the dyer immersed the cloth in a yellow dye such as that obtained from weld, after first dyeing with the woad.

Weld was the name given to *Reseda luteola*, sometimes also called dyer's rocket, a plant native to Britain. It grows in arable land and waste places such as railway embankments, especially on chalky soils. Weld is a biennial or perennial herb with upright stems 30-75cm (12-30in) high. The greenish-yellow flowers are in a spike and appear from June to August. It is another very ancient dye plant which, when used on its own, gives an exceptionally pure and bright yellow. In the Canterbury area of Kent and in Essex and Yorkshire crops of weld were specially grown.

To obtain reds, purples and violet colours, the dyers used madder, either on its own, or again combined with woad. The best red was obtained from *Rubia tinctorum*, a plant native to the Mediterranean region and the Near East, which was introduced to Britain and cultivated here. Madder belongs to the bedstraw family (Rubiaceae) and the dye was extracted from the roots. The roots of two closely related plants, field madder (*Sherardia arvensis*) and wild madder (*Rubia peregrina*), both native to Britain, were also used but they did not produce such good results, giving a pinkish red rather than the brilliant red of the introduced madder.

The decline of natural dyes For a long time natural dyes from plants were the only colouring agents available, but nowadays very few are still employed commercially. In the middle of the 19th century the discovery was made, by William Henry Perkin (an English chemist), of how to obtain artificial aniline dyes from coal-tar. He made purple while attempting to produce a substitute for quinine and from then on natural dyes gradually declined in importance as new colours were made and the modern synthetic dye industry developed.

PONDS: A PARADISE FOR INSECTS

The lush vegetation around the edges, the open water, the numerous submerged and floating weeds and the muddy floor make ponds a haven for many insects—and for amateur naturalists, provided they know a few tricks of the trade.

Ponds are packed with insects, the various species occurring in many different zones—around the water's edge, among the submerged plants, in the open water and on the muddy floor of the pond. The best ponds for finding insects have sloping sides and shallow edges with flourishing marginal vegetation. A

Above: An ideal pond in which to find insects.

Right: Rat-tailed maggots—dronefly larvae—live on the muddy bottoms of foul ponds, using their long 'tails' to breathe.

word of warning however. Be careful where you tread and try not to damage the vegetation. Probe with a stick before walking on suspect ground.

Equipment for pond hunting A water net is obviously essential if you are going to examine the insects closely, and so is a butterfly net for catching dragonflies, mayflies, caddisflies and other flying insects associated with water. You also need a few shallow pie dishes and a couple of clear plastic jars with screw-on lids, to transport specimens home for close examination–and for returning them to the pond again. Never fill a jar more than half full of water, as the creatures must be able to breathe oxygen.

Also useful is a small sieve or tea strainer and an old kitchen spoon. Don't forget a magnifying glass, a notebook, a pen and an old towel. Binoculars can be useful for looking at dragonflies which have settled on reeds far out in the centre of large ponds.

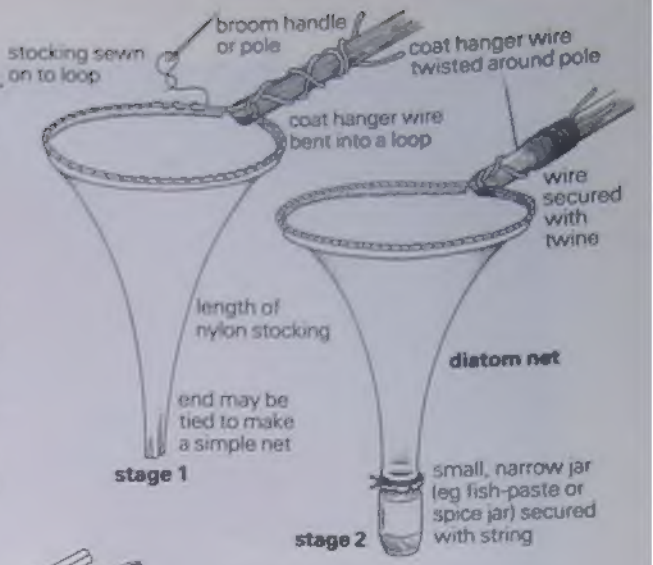
Marginal vegetation Around the edges of ponds you are likely to find a number of insects which are only associated with water for part of their lives. Many are brightly coloured, such as the darter dragonflies which can be seen catching smaller insects such as caddisflies, mayflies and mosquitoes.

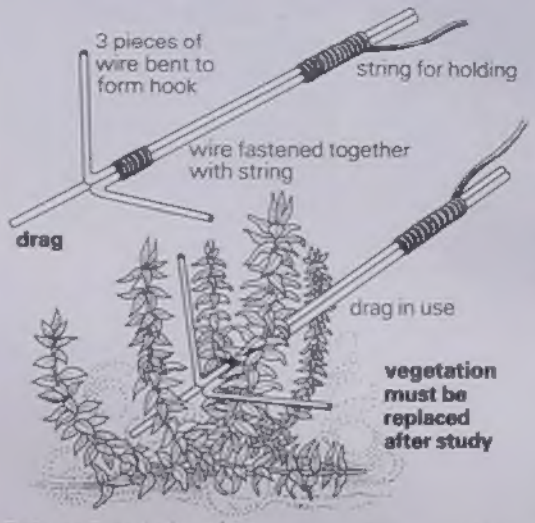
As you look at a pond you will notice that some plants grow around the edge in clumps composed of one or two species only. Common reed is one such species often extending out into the shallow water. Various species of rush (*Juncus*), with rounded stems, and sedges (*Carex*), with triangular stems, also occur by most ponds. Search among these plants and you may come across the greenish-blue or red-mauve *Donacia* beetles. If there is a clump of water mint, unmistakable by its smell, there are also likely to be a few brilliant green mint beetles, about 11mm long, lurking among the leaves. Also examine the nettle-like leaves of gypsywort, which has small white flowers from July onwards, and you may find the very flat, green tortoise beetle sitting on the upper surface of the leaves.

The stems and roots which creep along the mud at the water's edge are the homes of such insects as the larvae of the rush wainscot

A simple pond net . . .

To make a simple pond net, bend a wire coat hanger into a loop and wind the ends around a wooden pole. Secure the wire to the wooden pole with string. Then find a length of stocking, about 25cm (10in) long, and sew one end around the coat hanger. Sew the other end together to make a pond net (**stage 1**), or attach it to a small jar by tying string around the rim–thus making a simple diatom net (**stage 2**).



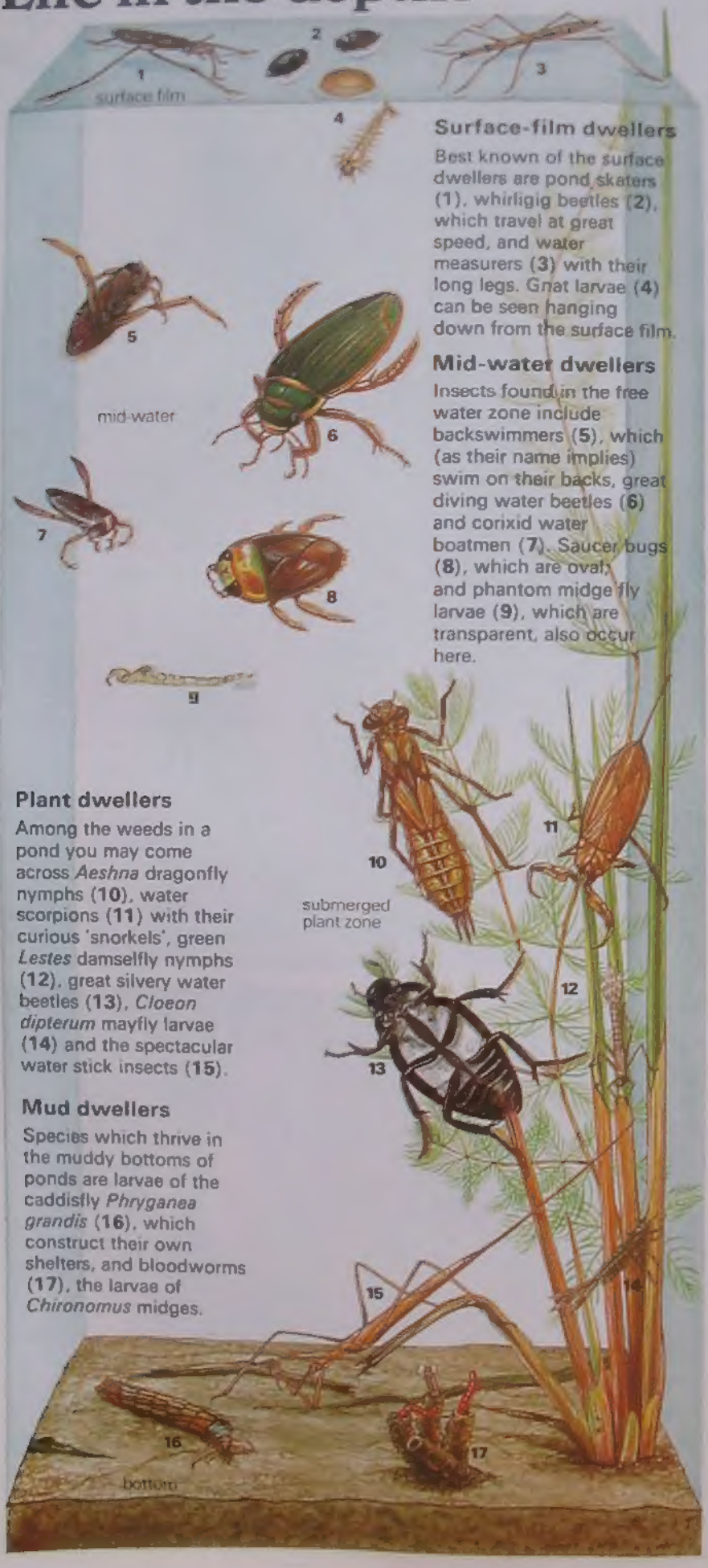


. . .and a drag

If you wish to examine the insect life on aquatic plants, a drag is useful. To make one, find three stout pieces of wire of the same length, and bend them at one end. Fasten the wires together with string–leaving enough string at the unbent end to hold. Throw the drag among a stretch of weed, and then pull it out and examine your catch. In the interests of conservation, do not pull out too much vegetation.

Below: Banded agrion damselflies roosting on aquatic vegetation. The adults are seen fluttering over water between May and August, but the nymphs live at the bottom of slow streams and ponds among the plant roots.

Life in the depths



Surface-film dwellers

Best known of the surface dwellers are pond skaters (1), whirligig beetles (2), which travel at great speed, and water measurers (3) with their long legs. Gnat larvae (4) can be seen hanging down from the surface film.

Mid-water dwellers

Insects found in the free water zone include backswimmers (5), which (as their name implies) swim on their backs, great diving water beetles (6) and corixid water boatmen (7). Saucer bugs (8), which are oval, and phantom midge fly larvae (9), which are transparent, also occur here.

Plant dwellers

Among the weeds in a pond you may come across *Aeshna* dragonfly nymphs (10), water scorpions (11) with their curious 'snorkels', green *Lestes* damselfly nymphs (12), great silvery water beetles (13), *Cloeon dipterum* mayfly larvae (14) and the spectacular water stick insects (15).

Mud dwellers

Species which thrive in the muddy bottoms of ponds are larvae of the caddisfly *Phryganea grandis* (16), which construct their own shelters, and bloodworms (17), the larvae of *Chironomus* midges.

moth, and larvae of the *Donacia* beetle. The latter bores into stems below water level with the two short spikes which protrude from its rear; these spikes are breathing tubes and air is drawn through them from the plants and into the larvae.

Surface dwellers Several species live on the pond's surface, so just by sitting quietly and watching, you should be able to see some activity. The long-legged pond skaters of the genus *Gerris* move jerkily around picking up small insects, such as aphids, which have fallen or been blown on to the water. The extremely thin water measurer steps sedately over the surface film with its long legs and body well clear of the water. Try picking it up – carefully – and it may feign death. You may also see a group of small black whirligig beetles charging about on the surface at a great speed, yet miraculously never bumping into one another.

With a pie dish or strainer try and obtain a sample of the floating egg rafts of mosquitoes (*Culex*), and their larvae and pupae from the water surface. The eggs float on the surface, but the larvae and pupae hang under the surface film – the gnat larva at an angle from the surface, and the mosquito larva (*Anopheles*) parallel to the surface.

Open water swimmers The next area in which to look for insects is the open water. Dip your net in the water and draw it backwards and forwards four or five times, sweeping through any submerged vegetation on which the swimmers may be resting. (Do not scrape the bottom at this stage.)

Your catch is best sorted out in a pie dish with clear water. The active swimmers are obvious at once – large or small stream-lined water beetles such as the great diving beetle and backswimmers of the genus *Notonecta* which, as their name implies, swim on their backs. Some insects, such as backswimmers, carry down a bubble of air which they use for breathing, coming up to the water surface to renew the bubble from time to time; this often gives them a silvery appearance on the undersurface.

The smaller, lesser waterboatmen (*Corixa* species) are often very common in ponds; they swim the right way up and occur in pondweed, water crowfoot and on the undersurface of such plants as water lilies. The oval, greenish saucer bug, a particularly good swimmer, is about 15mm ($\frac{1}{2}$in) long and has strong piercing mouthparts, capable of giving the human thumb a sharp prick.

Submerged plant home If you fish some of the plant material out of the water with a drag (see diagram) and float it in a pie dish, a number of insects may appear. Some will be true swimmers while others are species which clamber about the plants after crawling up from the bottom in search of food.

One fascinating larva, quite common in ponds, is that of the phantom midge fly. About 10mm long when fully grown, it is

extremely difficult [illegible]

[illegible] pond the [illegible] water [illegible] (*Ranatra linearis*) is a thin brown creature about 6-7cm (2in) long Its front legs are much shorter than the middle and hind pairs and are used for grabbing prey A close relation although physically dissimilar, is the more common water scorpion (*Nepa cinerea*), a flat oval creature brownish in colour Both have a long tail about one third of their body length, which is actually a breathing tube on the snorkel principle This allows them to take in water without exposing themselves to the dangers of predators above the water surface

The muddy floor The bottom of the pond which is the home of crawlers and mud-dwellers, can be scraped with the net to obtain specimens. In shallow water an old kitchen spoon attached to a long handle can be used to bring up samples of mud or sand for examination in a pie dish

Above Where there s stagnant water you can be sure there are mosquitoes Here you can see their empty larval cases in the centre - and their pupae The round bulky part of the pupa contains the mosquito s head thorax and abdomen

Above The insect population of ponds is greatly reduced by the feeding habits of such birds as coots

Left Pond skaters are surface insects, moving jerkily across the water as they feed If you manage to catch one examine it carefully with a lens, and you can see that the claw on the foot is situated before the tip so that it does not penetrate the surface film and hinder the insect s movement

You are almost certain to find some fearsome dragonfly nymphs, especially those of the darter flies A particularly rewarding sight is when the nymph crawls out of the water and on to a stem where it becomes transformed into a mature dragonfly all in a matter of an hour Also interesting to watch is the dragonfly nymph's feeding habits. Its mouthparts can suddenly shoot out to grab prey such as a worm, or even another dragonfly nymph. If the intended meal is not near enough to be grasped the nymph jet propels itself forward by a sudden expulsion of water from its rear end This action is best seen by placing a small amount of mud or sand in the bottom of the pie dish so you can see the jet of water

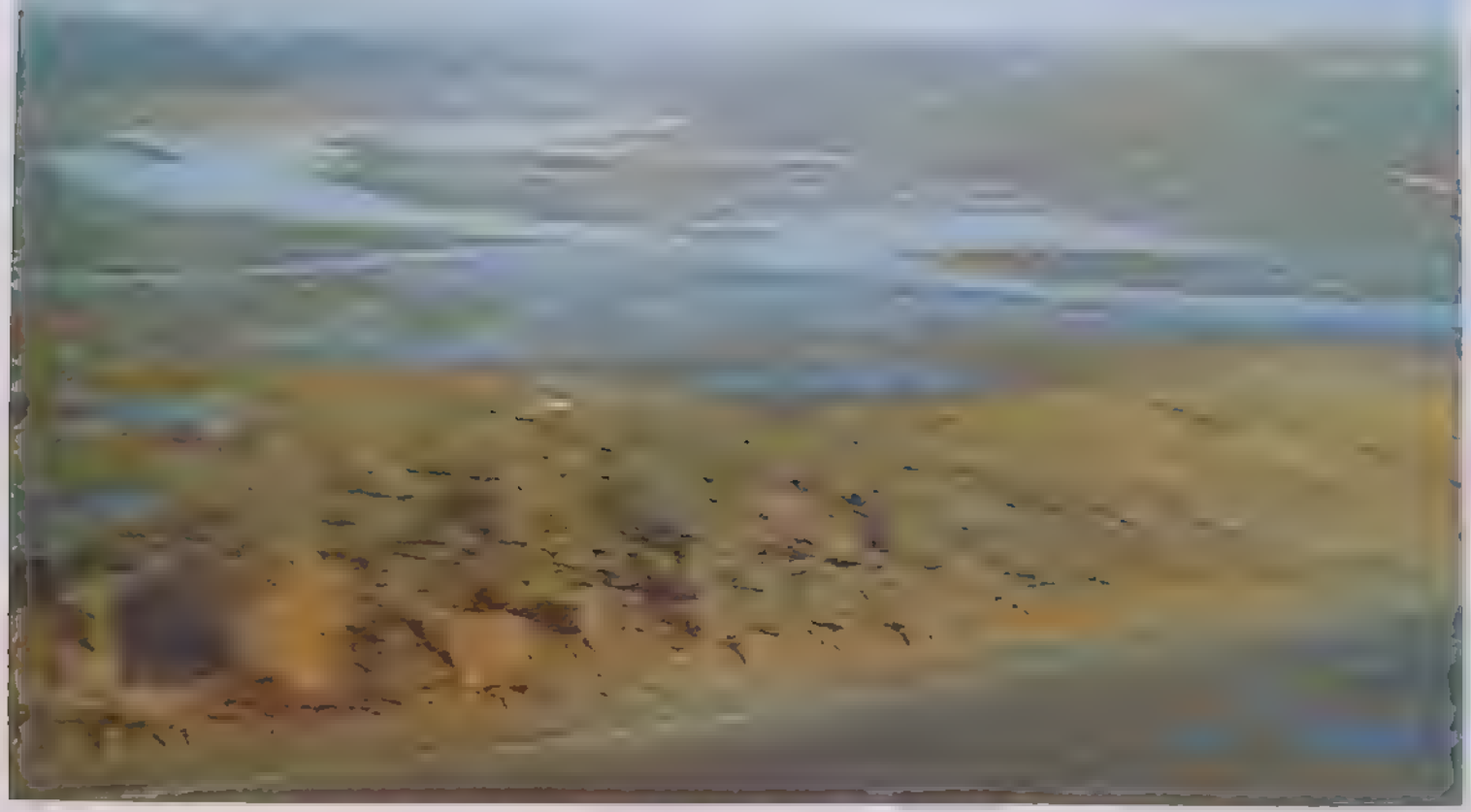
A good sample of mud from the bottom of a pond may well contain some bright red wriggly 'bloodworms' - larvae of *Chironomus* midges. Their red colour is due to the presence of haemoglobin, a substance which absorbs oxygen, so helping the larvae to breathe in rather stagnant ponds. These bloodworms can be mistaken for the little red *Tubifex* worms which usually live in clearer water and are true worms. The *Tubifex* worms have about 30 segments in their bodies, however, as opposed to 12 in midge larvae

Caddisfly larvae are well known for the curious shelter houses which many of them construct from pieces of plants, sand or small stones. They creep about the bottom and mainly inhabit the better aerated ponds *Phryganea*, a genus with several common species, has larvae which build cases of root, reed or other pieces of plants in the form of a neat spiral cylinder

Amateur research The food web in a pond is complex, and not easy to follow. Besides birds, fishes take a heavy toll of aquatic insects, but there is still much work to be done to find out exactly who eats what. Much of this is well within the scope of amateur naturalists who can make a real contribution to science in this area

THE DYFI ESTUARY

The Afon Dyfi (River Dovey) flows out into Cardigan Bay just north of Aberystwyth. Where it meets the sea it forms, at high tide, an expanse resembling a huge lake nearly two miles wide and five miles long–the Dyfi Estuary.



A typical fast-flowing west coast river, only 50km (31 miles) long from source to mouth, the Dyfi flows through some of the least spoilt countryside in mid-Wales. The waters of the Dyfi start their brief journey to the sea below the steep slopes of Aran Fawddwy near Dinas Mawddwy. The small glacial lake–Craigllyn Dyfi which nestles below the mountain on its southern slopes overflows to form the young river

The formation of the estuary The whole area has been fashioned by enormous natural forces. The striking ones are those of wind and water, both of which exert incredible influences on the system, as winter storms prove regularly, for with the river in full flood and storm force winds giving the tides and currents even more energy, the main course of the river channel can change in just a few hours. Less obvious perhaps, but even more dramatic, has been the influence of ice. This area of mid-Wales was covered by ice sheets up to 800m (2600ft) thick until only 14,000 years ago. These sheets of ice moved gradually west and fashioned the landscapes of today. During the past 10,000 years, the coastline around the Dyfi has changed considerably, for at the end of the last Ice Age the sea level was about 60m (200ft) below that of today. This meant that the shore was about 12km (7½ miles) west. The lowland area was gradually covered by forest. Some 10,000 years ago there was a sudden change in the climate which accelerated the melting of the remaining ice–the advancing sea level covered the low-lying land and drowned the trees.

By far the most significant changes have occurred in the past 150 years. Many of the remaining low-lying areas have been drained and the tidal influence of the sea has been restricted by the building of flood banks which

Above: A view of Dyfi Estuary, looking east, at low tide. There is a rich variety of habitats within the estuary, ranging from sand and mud flats to creeks and saltmarshes–all inhabited by a wealth of wildlife

Below The common lizard is one species to look for on the sand dunes

form the boundary of the estuary as it is today. Perhaps the most recent, and maybe the most important, influence that man has had took place in 1922, when three specimens of cordgrass (*Spartina anglica*) were planted on the mudflats at the eastern end of the estuary. The plants flourished and today approximately one third of the estuary is covered by cordgrass. The plants can grow well below high water, withstanding long inundation by the sea. They act as a barrier to the flow of water and slow the current down, and this in turn reduces the carrying capacity of the current, which drops particles of clay and silt among the stems of the cordgrass. The gradual raising of the level of the ground forms islands, which merge to form a higher area of saltmarsh. This is why the grass was planted.

Ynyshir Reserve The Dyfi estuary forms the centrepiece of a kaleidoscope of fascinating and varied wildlife habitats -from sand and mudflats to creeks and saltmarshes. The first of them is the RSPB reserve at Ynyshir.

Above: Biting stonecrop–one of the many plants found on the Ynyslas dune slacks

Left: Brown butterflies can be seen in abundance at Ynyslas–including this gatekeeper (a female)

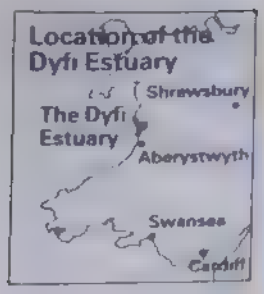
Below: The rabbit population at Ynyslas is high and attracts such hunters as this polecat to the dunes. Rabbits play an important part in the system for their grazing keeps down the taller vegetation, allowing smaller herbs to compete

The name Ynyshir means 'long island' and from the air the long rocky outcrops are clearly visible. The low-lying land around the estuary was marsh and bog until much of it was reclaimed for agriculture during the last century. Today, the rocky outcrops are covered in fine stands of sessile oaks. These oak woodlands play host to a vast number of insects and numerous birds exploit this rich food source, perhaps the most typical being the pied flycatchers, many of which use the nestboxes on the reserve. Nearly 70 species of birds breed at Ynyshir and the area is a delight in the spring. However, the most impressive time of year for the birdwatcher comes during the spring and autumn migration. The RSPB has installed excellent hides with views over the saltmarshes

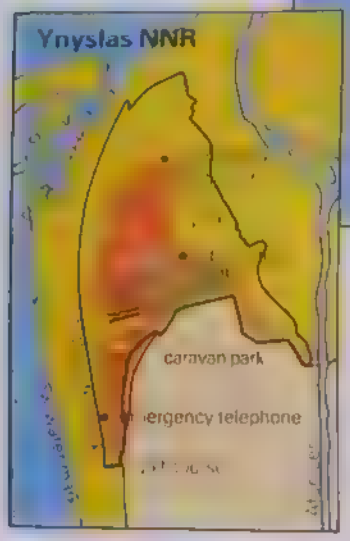
Ynyshir also has a good selection of butterflies–the most typical is perhaps the speckled wood. Purple hairstreaks are common in the woodlands, where the caterpillars feed on the oak and the butterflies can often be seen during July and August around the tops of the trees

Sandflats and mud banks Probably the most obvious features of any estuary are the extensive areas of sand and mud banks exposed twice a day at low tide.

At first glance, an estuary at low tide looks devoid of life, but a closer inspection of the ground will show a different picture. The most obvious sign is that of the lugworm which is often very abundant. Like this worm, all the animals must be able to escape from the surface–to avoid being swept away by the currents, preyed on and to protect themselves from drying out at low tide. Many animals build permanent burrows like the lugworm and most of them inhabit the first few centimetres of the surface. One of the most numerous is the small shrimp-like crustacean



dunes
sand
peat bog
wooded areas



sandy shore
strandline and foredunes
mobile dunes
fixed dunes
dune slacks
route of nature trail
NNR boundary

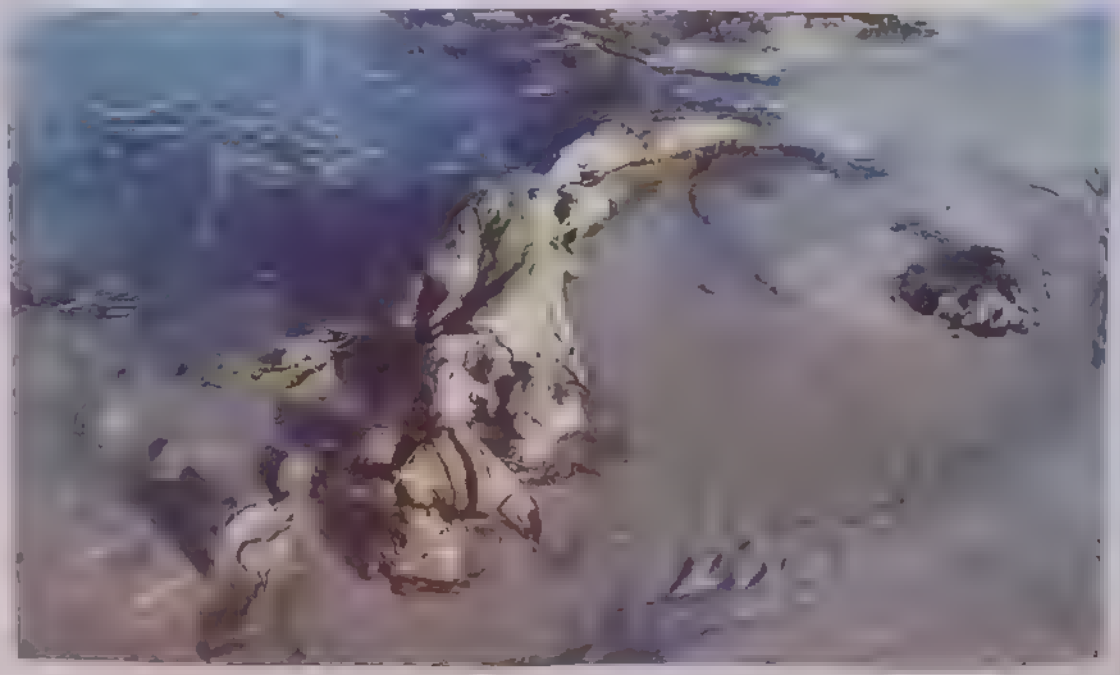
Above: Maps of the Dyfi Estuary and the Ynyslas area. Because the Dyfi affords a classic example of a west coast estuary, with its mud and sand flats, creeks and saltmarshes, together with its attendant habitats–a shingle ridge and sand dune system and an estuarine raised mire–it has been selected as a National Nature Reserve by the NCC. Today, the 2000ha (4942 acres) of National Nature Reserve adjoin the 250ha (618 acres) of the RSPB reserve of Ynyshir (with its saltmarshes, unspoilt woodland and fine heather-clad hill slopes overlooking the estuary), and provide a very fine example of coastal habitats.

and supports a large number of wading birds on migration to and from their breeding grounds in the north. The estuaries act as refuelling points along the west coast of Britain. The area is also important for its winter populations of wildfowl. The shelduck chiefly exploit the invertebrate food source but others like the Bar, teal, pintail and wigeon, are mainly vegetarian. They feed on the abundant food washed in by the water and frequently dabble along the edge of the incoming tide. They also exploit the wet fields, ditches and marshes adjacent to the estuary. There is also a small resident flock of Greenland white-fronted geese on the estuary –the only flock to be found in England and Wales.

Like the invertebrates, the plants too find it easier to colonize the more stable mud; the sand banks at the estuary mouth are devoid of any vegetation. The first colonizer is the long slimy alga *Enteromorpha*, but more typical is the glasswort (*Salicornia*) which is the first true colonizer of the bare mud. Cordgrass is called *Corophium*, which is often present in large numbers and gives the surface of the mud a pepper-pot texture. Many wading birds –dunlin, sanderling and ringed plover– exploit this rich food source. Two molluscs typical of estuaries are the peppery furrow shell, which lives deep in the mud, and the Baltic tellin, which lives near the surface this attractive pink mollusc is an important food for the redshank.

Perhaps the most impressive of all the invertebrates is the laver spire shell, as many as 50,000 individuals inhabiting one square metre. It feeds on the surface of the mud and leaves a tell-tale maze of minute tracks. The shelduck, our largest native duck, feeds on it.

It is not surprising that, with such vast food reserves, estuaries are so important for bird populations. The Dyfi estuary is no exception



Top: Dyfi Estuary–the view from Borth Bog in the depths of winter

Above In order to prevent erosion some of the sand dunes are contained by fences, placed slanting across the slopes

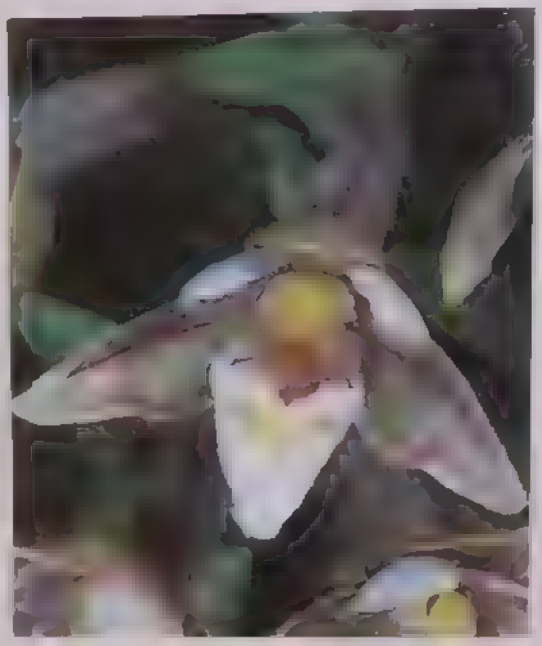
Left The remains of a submerged forest can be seen on the beach just south of the estuary–stumps of Scots pine, birch and alder are exposed at low tide They may be as much as 10,000 years old

Right: The dune slacks are rich in plants, with eight species of orchids growing there in summer This marsh helleborine is one of them

the most abundant plant, while further up the marsh thrift, sea aster and sea spurrey are more common. At the very top of the saltmarsh, where only the spring tides reach, grow other plants such as common reed and scurvy grass

Ynyslas–shingle and sand dunes At the mouth of the estuary lies the last of the main habitat types–the shingle spit and sand dune system known as Ynyslas (a blue-green island). It gets its name from the distinctive colour of the marram grass and the fact that for many hundreds of years the dunes were an island at high tide

The dunes form a rich wildlife habitat and are a botanist's delight. On the shore line only those plants adapted to the harsh environment of blowing sand, salt spray and even the occasional inundation by sea water



can survive. Typically, they are annuals and have thick fleshy leaves to withstand the hot dry conditions. The plants, such as sea rocket and prickly saltwort, grow on the highest tide strand zone, where they take advantage of any organic material, such as seaweed, that has been washed up. Behind this strand zone, small hedgehog-like dunes appear, held together by marram.

Behind this protective wall of high dunes, the vegetation changes and becomes far more varied -this area is called the grey dunes because of the increased organic content of the sand that gives it a grey coloration. Typical plants of this area are carline thistle, germander speedwell, common stork's-bill and dove's-foot crane's-bill

This increase in the variety of plants is echoed by the variety of butterflies. The commonest species are the browns–meadow brown, gatekeeper and grayling–but the small heath and common blue also appear, and the dark green fritillary is abundant

The jewel of the dune habitats is the dune slacks, the damp hollows between the dunes. These fill up with fresh water in the winter and gradually dry out in the summer. They are very rich botanically and during June and July there are eight species of orchids to be found growing there. The most abundant is the marsh helleborine, with its beautiful cream flowers–these were first recorded at Ynyslas in the mid 1960s and today there are well over 150,000 spikes.

There are no permits required to visit Ynyslas dunes or the Dyfi estuary, but you are advised to visit the Information Centre at Ynyslas before you go on to the reserve. The NCC holds afternoon walks once every week throughout the summer and you can obtain a list of these by writing to NCC, The Information Centre, Ynyslas, Borth, Dyfed.

THE EXOTIC HOOPOE

The hoopoe, which arrives in Britain as an 'overspill' from the Continent, belongs to a small band of colourful birds whose main breeding range is in the Mediterranean basin.

The hoopoe is a familiar bird to many sun-seeking holidaymakers from the British Isles who visit any of the countries from Greece in the east to the Iberian Peninsula and the Canaries in the west. The British Isles are just beyond the hoopoe's main breeding range, but very few summers pass when hoopoes do not arrive here. A few stay to breed -most frequently in hot, dry summers–while the number of non-breeding individuals throughout the country in any one year can be considerable

These breeding attempts are clearly unusual cases, in which birds have 'overshot' their normal Continental breeding areas while migrating northwards in spring. From year to year, hoopoes are recorded arriving across the Channel in southern English counties from March onwards. Spring records are often unexpectedly early in the year, for the hoopoe is one of the earliest migrants to cross the Sahara on its spring migrations.

Singular species The hoopoe is a highly distinctive bird, virtually impossible to confuse with any other. The sexes are alike, and the basic plumage colour is a soft cinnamon brown, often described as pinkish by observers in the field. The basic colouring is strongly broken up by the conspicuous black and white bands on wings and tail. If these features alone are not sufficient to distinguish the bird, the bill is long and downcurved, and the head is adorned with long crest feathers, strongly tipped with black. The hoopoe raises

Above: The effortless, almost butterfly-like wingbeats of the hoopoe belie its great powers of flight

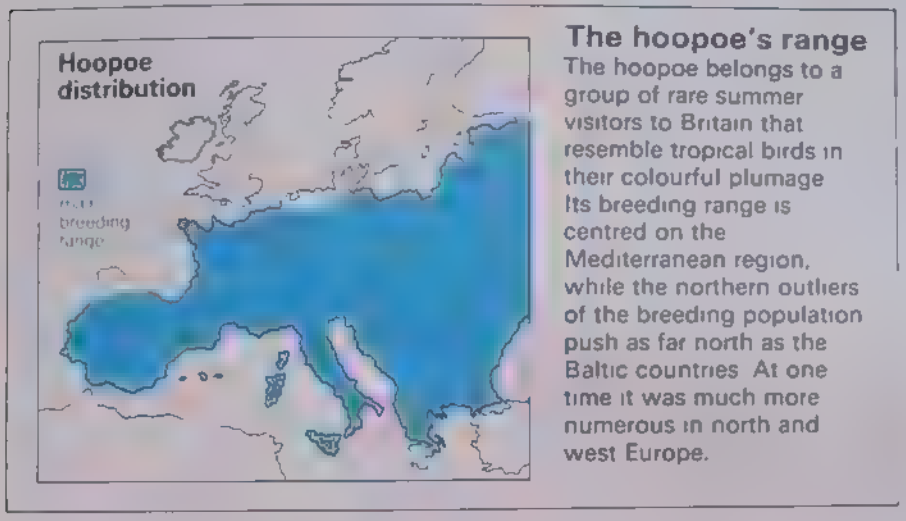
Hoopoe (*Upupa epops*)
Rare summer visitor to old orchards, woodland edges and pasture Sexes alike
Length 28cm (11in)

Below: Hoopoes are pleasantly confiding birds and are relatively unaffected by man's presence. They often nest in walls and old buildings

and lowers its crest freely, especially when excited, agitated or alarmed, and also does this momentarily each time it lands.

Calls and flight The hoopoe draws attention to itself by its low, distinctive 'hoop, hoop, hoop' call. Although this is a soft sound it has remarkable carrying powers, and is often audible from up to 1km (½ mile) away. The cock bird calls frequently during the breeding season, either from the ground or from a tree or similar prominent place. His calling, especially during the early part of the season, is accompanied by bowing actions, and much raising and lowering of the long crest.

In flight, the hoopoe is equally distinctive. When not travelling far, it flies with almost lazy, butterfly-like beats of its broad, rounded black and white wings. This floppy flight disguises a genuine ability to cover long distances efficiently, as witnessed by its trans-Saharan and trans-Mediterranean migration flights, and certainly when moving for cover on the approach of a predator it can show a remarkably good turn of speed.



The hoopoe's range

The hoopoe belongs to a group of rare summer visitors to Britain that resemble tropical birds in their colourful plumage. Its breeding range is centred on the Mediterranean region, while the northern outliers of the breeding population push as far north as the Baltic countries. At one time it was much more numerous in north and west Europe.

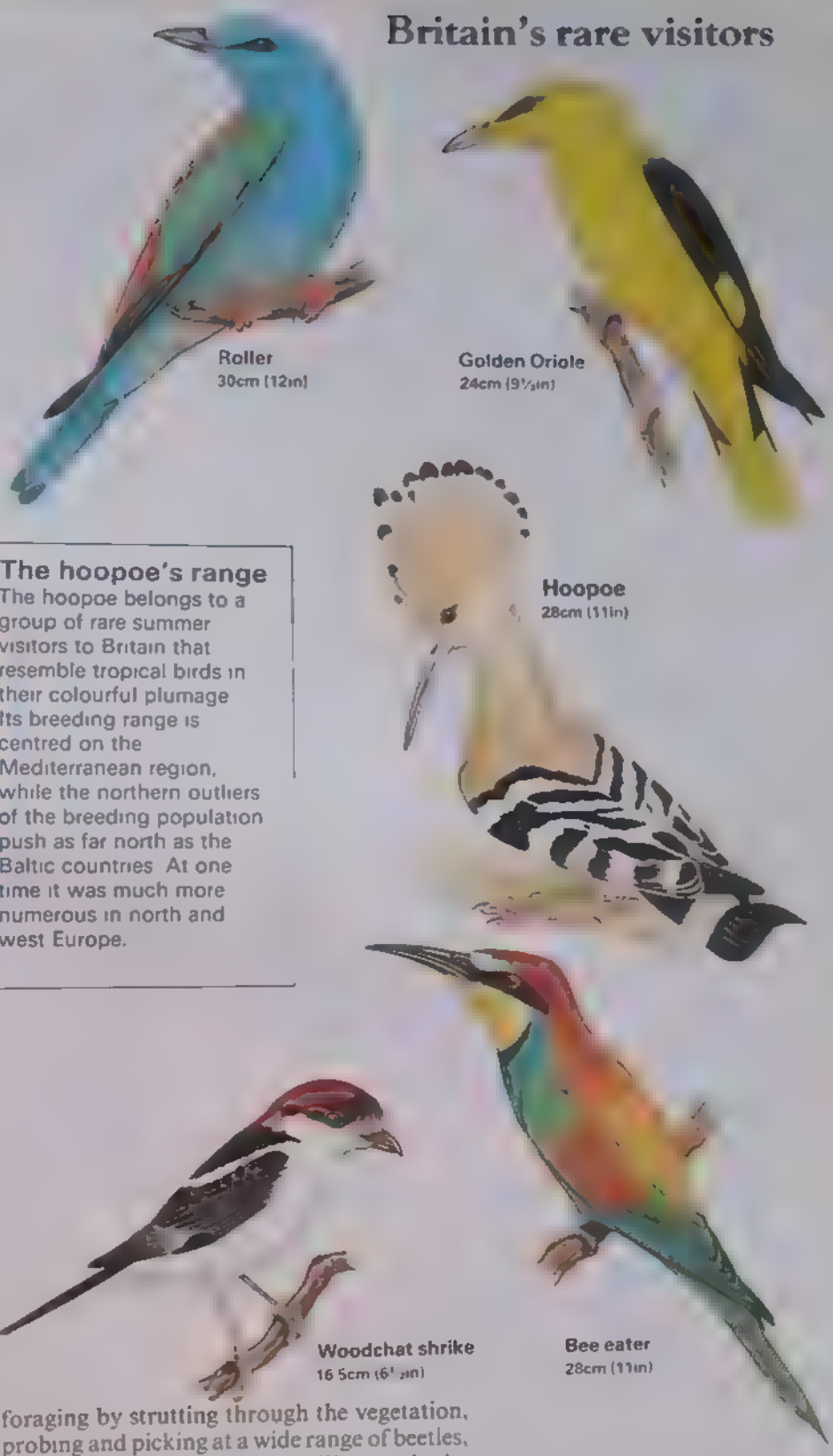
Breeding behaviour When pairs do settle and breed, or attempt to breed here, it is predictably the southern counties of Britain that are the most favoured. The most northerly breeding sites recorded are in Lincolnshire, Herefordshire and South Wales. In the breeding season, hoopoes inhabit old orchards, woodland edges, parklands and similar places where trees afford nesting holes and adjacent fields and pastures provide feeding sites.

For nest sites, hoopoes show a strong preference for tree holes, often with narrow entrances, from ground level up to a height of 3m (10ft) or more. In treeless areas, such as parts of North Africa and indeed any treeless parts of the British Isles where they make a landfall, the birds nest in crevices in stone heaps, old buildings and walls. Once the nest site has been selected and the pair is firmly established, little is done about lining the hole or building a nest, although some pairs carry in grasses or straw.

Small prey The hoopoe is largely an insect eater, finding all its food on the ground and foraging by strutting through the vegetation, probing and picking at a wide range of beetles, grasshoppers, spiders, woodlice and the larvae of flies, moths and other insects. It also takes earthworms and even small lizards.

Returning south Just as the hoopoe is an early arrival in Europe in spring, so it is among the first to start the return migration in autumn. The earliest departures take place by the end of July, while passage continues into October. In this season, a small and short-lived wave of fresh arrivals is seen in Britain: these are probably individuals from the small breeding populations in north Germany and southern Scandinavia. The winter destination is the savanna land south of the Sahara.

Britain's rare visitors



Above: In most summers, all these exotic-looking birds are liable to appear in small numbers in the southern counties of the British Isles. They are all southern species wintering in Africa and migrating to the Mediterranean basin and beyond. Only the hoopoe and the golden oriole are known to breed here, but the others are seen as summer accidentals

LICHENS OF DUNGENESS

Despite the inhospitality of its shingle, Dungeness is one of the most important sites for lichens in the whole country, with well over a hundred different species to be seen.

Above One of Dungeness s two lighthouses The shingle vegetation includes sea-kale and a species of *Rumex*

Right. The black encrusting lichen *Rhizocarpon constrictum* on the pebbles of Dungeness This lichen forms a zone that extends from the drift line inland for about 300m (1000ft) and along the southern coast for about 5km (3 miles) In some parts *Rhizocarpon* covers about 25% of the shingle

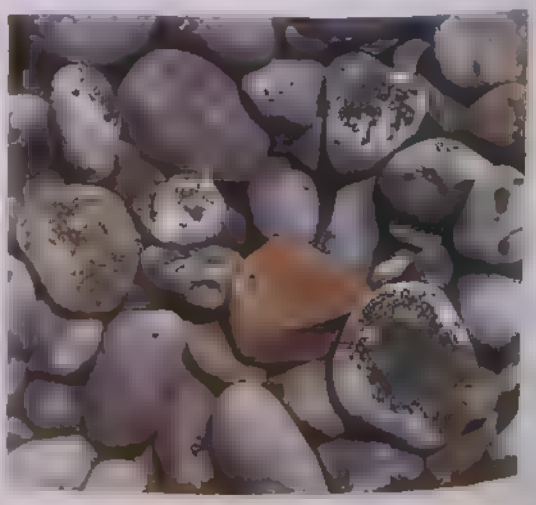
Shingle beaches are among the least hospitable habitats for plants and animals. The ground is composed of rounded pebbles, over which there is little or no soil. The pebbles are unstable, being subject to movement by wind, water or trampling There is no shade from the heat of the sun, and little respite from the seemingly relentless winds carrying salt spray which can be so damaging to wildlife. Not surprisingly, in such extremes only a few specially adapted plants and animals can flourish, and among these are certain lichens

In Britain the largest and most important area of shingle beach is at Dungeness, a flat headland jutting out from Kent into the English Channel. The shingle consists almost entirely of flint pebbles and extends inland for a distance of 7km (4 miles), which makes it probably the largest such area in the world

Five beaches Over the years the sea has heaped up the pebbles into shingle ridges separated by belts of marsh. The result is a series of beaches that have been formed successively from west to east: Jury's Gap Forelands, Holmstone, West Ripe and Denge Beach. The most recent of these, Denge Beach, was mostly formed between about the years 750 and 1600. Today, it is the most extensive and important beach of the five

Shingle colonizers Along the south coast of Dungeness is a prominent man-made ridge of unstable shingle. The only common plant growing here is sea-kale, which grows on top of the ridge and down the landward side. Apart from some small scattered areas of saltmarsh, the area on the landward side between the ridge is mostly bare dry shingle. The first plants to colonize this shingle are crustose lichens. On pebbles close to the drift line the dominant species is *Rhizocarpon constrictum* which is seen as blackish patches on pebbles Away from the drift line *R constrictum* declines, to be replaced by other encrusting lichens, among which is *Parmelia glabratala* subspecies *fuliginosa*, a shiny, dark greenish-brown lichen with lobes

Once *R. constrictum* has begun to establish itself, communities of *Cladonia* lichens begin to develop. *Cladonia* is a large and important genus of lichens, representatives of which can



be found at the bases of tree trunks as well as on rocks and pebbles. At Dungeness the most common species near the sea is *C. rangiformis* which forms bushy clumps of whitish-grey forked stems. Also found here are *C. foliacea* and *C. cervicornis*. Both are leafy lichens, the former being yellowish-green and the latter pale grey, and both are characteristic of bare shingle. One of the main flowering plants on the site is English stonecrop, a fairly common plant of shingle beaches.

Lichen heath In thicker vegetation *Cladonia portentosa* soon becomes conspicuous, with its pale greyish-green, finely branched stems. Away from the sea, this lichen becomes dominant, forming what is known as a lichen heath. This heath extends over much of Denge Beach and contains a range of plants other than *C. portentosa*. Wood sage, sheep's sorrel and fine-leaved sheep's fescue are all found here. Among lichens, *Cladonia gracilis* is the species most constantly seen among the stands of *C. portentosa*. Also found on this lichen heath is *Cladonia mitis*, Dungeness being the only site in England where it is found. This lichen is thought to be one of the first plants that recolonized Britain after the last Ice Age. *C. mitis* was probably much more common then but, as trees began to establish themselves, it retreated to open habitats along the coast. (It is believed that Nottingham catchfly, which is a member of the campion family, survived at Dungeness in the same way.)

Also present on the lichen heath is a prostrate form of broom, which is involved in a unique vegetation cycle. The broom dies from its centre, the rotting wood forming a layer over the shingle which is colonized by the lichen *Cladonia chlorophaea*, a greyish-green leafy species with cups. As the wood decays so does the lichen, and it becomes replaced by *C. portentosa*. The area is then recolonized by the broom and the cycle is repeated.

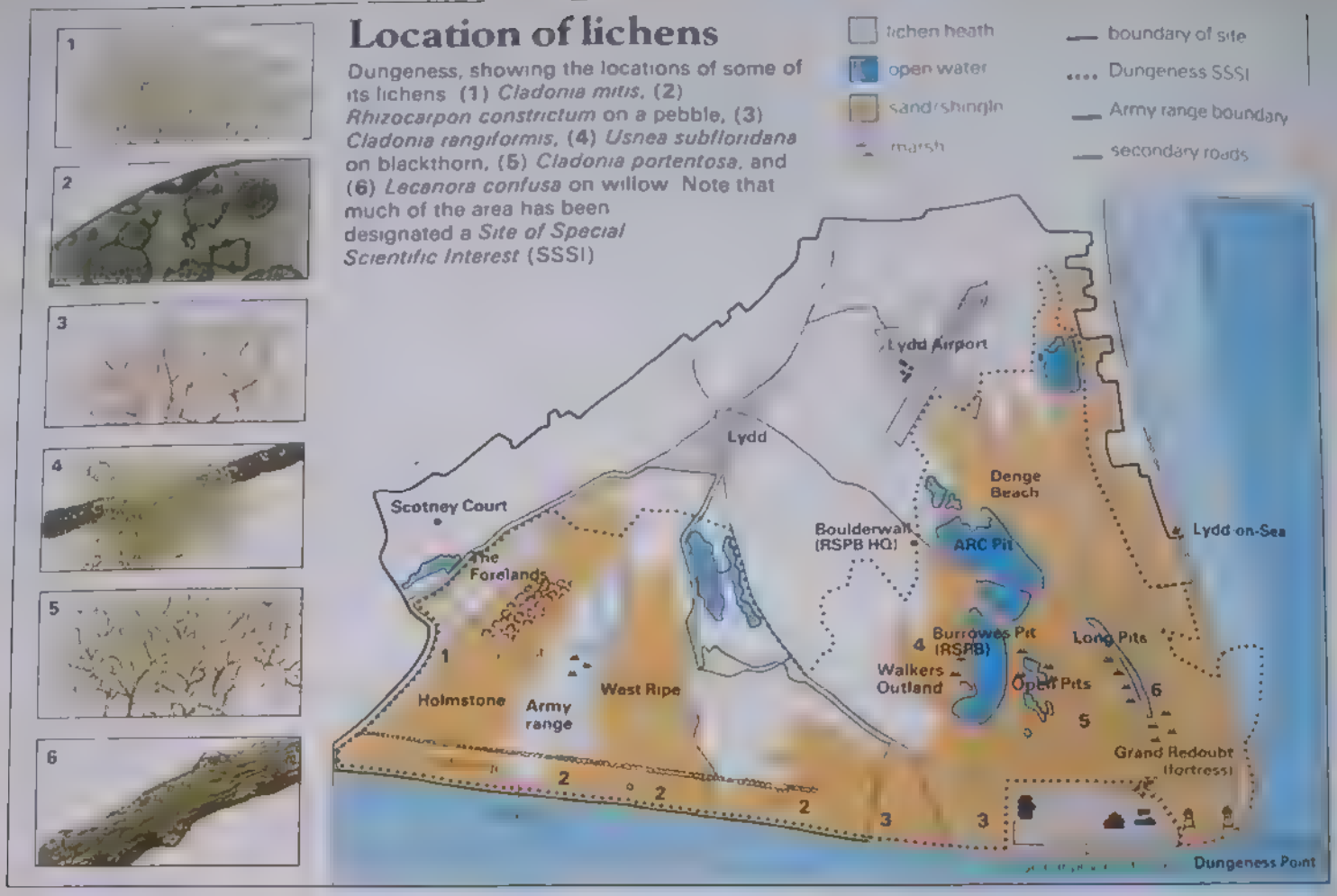
Lichens of blackthorn All the beaches of Dungeness have shallow valleys on their landward sides where patches of dwarf blackthorn scrub grow. The bushes are often richly covered with fruticose lichens—lichens that consist of many strap-like or finger-like branches. Particularly common are *Evernia prunastri*, *Hypogymnia physodes* and *Usnea subfloridana*, all greyish-green in appearance. The most interesting lichen on the blackthorns is *Usnea glabrata*, because it was thought for a long time to be extinct in Britain.

Unfortunately, however, the lichen flora of the blackthorns is gradually diminishing. At least seven species of lichen recorded during the last century now no longer grow there, including lungwort (*Lobaria pulmonaria*) which is now confined almost entirely to the west of Britain. It was recorded that lungwort covered 'nearly an acre of ground profusely'. This was apparently 'on the sand not far from

Right: English stonecrop can be found close to the sea among the community of *Cladonia* lichens. A succulent evergreen perennial growing to no more than 5cm (2in) tall, it produces pink flowers from June to August.

Below: Sea-kale, in both flower and fruit, on the shingle at Dungeness. The flowers are typical of members of the cabbage family: small, white and four petalled. They are borne on somewhat flat-topped heads between June and August.

Bottom: A stand of *Cladonia portentosa*, the major constituent of the lichen heath found over much of Denge Beach.



Below: Gravel winning on Denge Beach, an activity that has been going on since the 1950s and which seriously threatens the future of Dungeness as an important site for plants. The stretch of water on the right of the picture is an artificial lake called the ARC Pit. It was created by the first excavations for gravel

the cultivated fields'. None of these lichens has been seen at Dungeness during the present century

Holly scrub On Holmstone Beach about 300 ancient holly bushes remain, forming an area of open scrub. These bushes are the relicts of a wood that once grew on the site naturally–it seems probable that the beach itself was named after the holly wood which once covered it, holm being the old name for holly. A Saxon Charter of the year 741 refers to a 'wood called Ripp', Ripp coming from 'ripae', which means shingle banks. It gave its name to West Ripe, the beach now next to Holmstone. In 1539, Leland's *Itinery* reported a 'great numbre of holme trees . . . beyond Lydd . . . upon a banke of b(e)aches', Lydd lying just north of Dungeness. Since this ancient woodland has never shown any signs of further development, it must be regarded as the climax vegetation. In other words, it is the end point of a succession of colonizations by different plants.

The holly scrub is unique in Britain, but unfortunately it is also poor in lichens. A younger holly wood, formed during the last century, once grew on Forelands Beach, but elsewhere there are only very isolated bushes growing, and they may have been planted.

Dungeness also has some damp hollows and ponds, the largest of which is the northernmost of the Open Pits on Denge Beach. Here, some important aquatic and marsh communities occur, which gradually give way to undisturbed areas of *Sphagnum* bog and willow carr. The carr has a good lichen flora, the most abundant species being *Lecanora confusa*, a greyish encrusting lichen

Clearly Dungeness is a site of international importance, with 142 species of lichen known from the area plus another ten awaiting confirmation. It was listed as a proposed National Nature Reserve as long ago as 1915, so it is sad to relate that the site has still not been protected in this way.

STRONG-SCENTED VALERIANS

One of the smallest of our plant families, the valerians have just five members native to Britain, with a few more naturalised here. They have long been noted for their culinary and medicinal qualities - despite their sometimes disagreeably strong smell.

Above Common valerian bears large heads of pale pink flowers between June and August. Individually each flower is minute–about 4mm across–the petals being fused to form a funnel-shaped tube which divides at the top into five lobes. In this species the anthers mature before the stigma becomes receptive, thus preventing self pollination. Only when all the pollen has been shed do the stigma lobes pull apart, allowing the flower to be fertilised.

Although they form a small family the valerians are widely distributed throughout the world, having representatives in North and South America, Asia and parts of Africa, as well as Europe. All members of the family are herbaceous and many are characterised by a distinctive strong smell given off when the leaves or stems are crushed. Cats are particularly attracted to the odour, as are rats.

In Britain, the valerian family is represented by three genera, of which only two are native to this country. The largest group of plants is the genus *Valerianella*–four of our five native valerians belong to this genus. They are all small annual herbs and the most widespread species is lamb's lettuce, also known as cornsalad

Lamb's lettuce A small slender plant growing no more than 40cm (16in) high, lamb's lettuce is found in a variety of habitats such as arable land, hedgebanks and sand dunes, in particular thriving on dry soils. Occasionally it has been cultivated in gardens for use as a salad vegetable, the young leaves being picked and eaten while still young and tender

Lamb's lettuce has slightly angular, much-branched stems bearing leaves in opposite pairs, the leaves at the base of the plant being broader than those higher up. The pale lilac flowers are clustered together in small rounded heads on the ends of the branches. Each minute flower has a funnel-shaped corolla (or petal-tube), dividing at the top into five spreading lobes. The corolla contains three stamens and a style, all of which protrude slightly from the mouth of the funnel. The stamens and stigma mature at the same time so that, if insects fail to pollinate the flower, it can pollinate itself.

Cornsalad fruits The other species of *Valerianella* found in Britain are very similar to lamb's lettuce, and can only be identified positively by examining the ripe fruits. All species of *Valerianella* (or cornsalads, as they are known) have a fruit consisting of three compartments called cells, one of which contains a seed while the other two are sterile and empty. Small differences in the shape and

Left Though not native to Britain the red valerian thrives here, particularly on cliffs old walls and other sunny places Plants with white or pink flowers are often seen as well as red flowered forms

Right Marsh valerian showing its distinctive broad basal leaves

Why the name?

The name 'valerian' is believed to come from a Latin word, 'valeo' meaning to be healthy, though it has also been claimed that the plants were named after a Roman physician named Valerius. Either way, both origins indicate that the plants have long been valued for their medicinal properties. Common valerian, in particular, was especially valued as a sedative for those with nervous complaints, and was also used to heal wounds An infusion is still drunk in Germany

size of the fruits of different species enable them to be identified.

Lamb's lettuce has a compressed fruit measuring about 2.5mm long by 2mm across, with a corky swelling on the cell containing the seed. The very similar keeled cornsalad has an oblong fruit measuring about 2mm long by less than 1mm across and it lacks the corky swelling. This species is less common than lamb's lettuce, being found in cornfields and on hedgebanks and old walls. Our two other native cornsalads are the sharp-fruited and the narrow-fruited cornsalad, their common names indicating how their fruits differ from each other. Both species have a conspicuous hollow tooth at the top, which serves to distinguish them from the other species, and both grow in cornfields.

One other species of *Valerianella* seen in Britain, *V. eriocarpa*, was introduced here from the Mediterranean and North African region. It has now become naturalised on banks and old walls in a few counties, mainly in southern Britain.

Common valerian The remaining British valerians come from the genera *Valeriana* and *Centranthus*, and all are perennial. Three species belong to the first genus, of which the most widespread is the common valerian.

This plant can be seen growing in rough grassy places and the edges of rivers and ditches where the soil is wet. It usually grows in clumps, its tall erect stems reaching to a height of 1.5m (5ft), which makes it a conspicuous plant. The leaves are arranged in opposite pairs up the stem, each leaf being divided into pairs of leaflets, usually between four and six.

From June to August common valerian produces heads of pale pink flowers. Each flower is more or less the same shape as that of lamb's lettuce, though there is one difference – towards the base of the corolla there is a small

Right. The eight species of native and naturalised valerians. Those in the genus *Valerianella* are all very similar and best distinguished by examining the seeds (shown in insets)

Below: The pale lilac flowers of lamb's lettuce appear white from a distance

pouch containing nectar. The nectar and the sweet fragrance given off by the flower attract many insects, particularly butterflies which are the main pollinators. The fruits are dispersed by wind, aided by a feathery parachute of white hairs.

Also in the genus *Valeriana* is the marsh valerian, a much smaller and less common plant than common valerian. It occurs in marshes and wet meadows, growing to a height of 15-45cm (6-18in). The flowers appear in May and June, males and females being borne in separate heads. The female flower heads are smaller, more tightly arranged and darker coloured.

Red valerian The one remaining plant in Britain belonging to the valerian family is red valerian, in the genus *Centranthus*. It was introduced here from the Mediterranean region during the 16th century and has become naturalised in many parts of the country. Red valerian grows to a height of 75cm (2½ft) and has smooth bluish-green stems and leaves. The flowers are borne in branched clusters from June to August. The typical flower colour is red but pink forms and white forms are also common. The flower structure is similar to that of other valerians: a slender corolla tube is divided at the top into five petal lobes. Inside this is a single stamen and the style, which both extend beyond the entrance to the tube. The fruit consists of a seed borne on a feathery parachute.

Native and naturalised valerians

Keeled cornsalad
(*Valerianella carinata*)

Sharp-fruited cornsalad
(*Valerianella rimosa*)

Narrow-fruited cornsalad
(*Valerianella dentata*)

Lamb's lettuce
(*Valerianella locusta*)

Red valerian
(*Centranthus ruber*)

Common valerian
(*Valeriana officinalis*)

Marsh valerian
(*Valeriana dioica*)

RETREATING WRYNECKS

Our only long-distance migrant in the woodpecker family, the wryneck has been badly affected by changes in land use and climate, and has now ceased to breed in Britain.

So far as can be gleaned from recorded observations of previous centuries, wrynecks were once common summer visitors here, breeding in most counties in England and Wales, and certainly as far north as the Lake District. Since the early years of the 19th century, however, numbers have gradually dwindled and their range has contracted. A bird census in 1955 suggested that, as a British breeding bird, the wryneck would be extinct by about 1980. In the event, there has been no breeding record since that year, and the bird has thus been reduced to the status of a relatively uncommon passage migrant, seen more often in autumn than in spring.

Woodpecker-like traits The wryneck is a unique member of the woodpecker family, sharing some of the characteristic features of woodpeckers but at the same time demonstrating a marked individuality. Take the similarities first: the bird has a powerful chisel-shaped beak, useful for excavating in wood and soil and, less visible but more important as a link with the woodpeckers, a long tongue, which when not extended is coiled in a sheath behind the skull. In use it

Above A wryneck in its typical near-horizontal posture Autumn is the most likely time to see this passage migrant, on its way to its African wintering grounds The birds we see in Britain are part of the Scandinavian population, and must therefore be strays that have flown temporarily off course Smaller numbers are seen on the return migration in spring

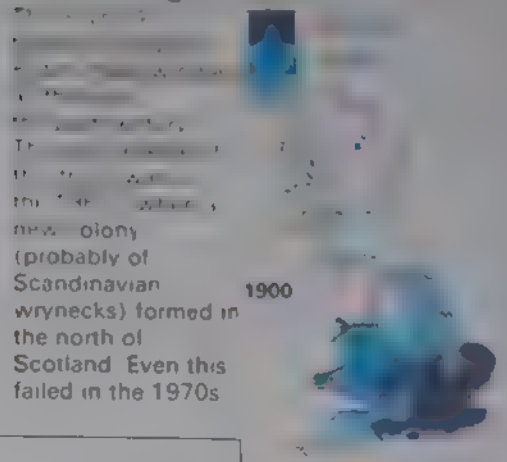
Wryneck (*Jynx torquilla*) Passage migrant; a member of the woodpecker family Ceased to be a British breeding bird around 1980 Sexes alike. 16cm (6½in)

Left: A wryneck stretches upwards with its snake-like neck The plumage is a mixture of brown, buff and grey, with paler underparts

Right: When they did nest in Britain, wrynecks often favoured natural hollows in trees. they did not excavate their own nests. Alternatively (as shown), they used 'second-hand' nest holes made by woodpeckers

Features of the wryneck

A declining situation



new colony (probably of Scandinavian wrynecks) formed in the north of Scotland. Even this failed in the 1970s

can be protruded along ant runs: its sticky saliva coating immobilises the ants, so that they can be withdrawn and eaten. Ants are the wryneck's major food source, although it takes a wide variety of other insects, together with some fruits and nuts.

The call of the wryneck is a shrill, piping 'quee-quee-quee', similar to, though rather drier in tone, than the lesser spotted woodpecker's 'pee-pee-pee' call. The wryneck's feet, too, are woodpecker-like, with the unusual two-forward, two-back arrangement of the strong toes. In fact the wryneck is far more terrestrial in its behaviour than its relatives, so this climbing adaptation is, as it were, partly 'wasted'.

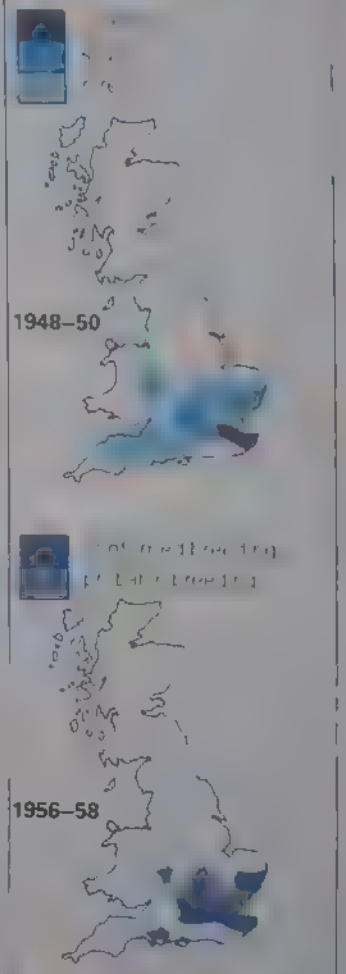
Differences from woodpeckers In listing the dissimilarities, too, we can start with climbing, for the wryneck has soft tail feathers, not the strong 'shooting stick' props found in the woodpeckers.

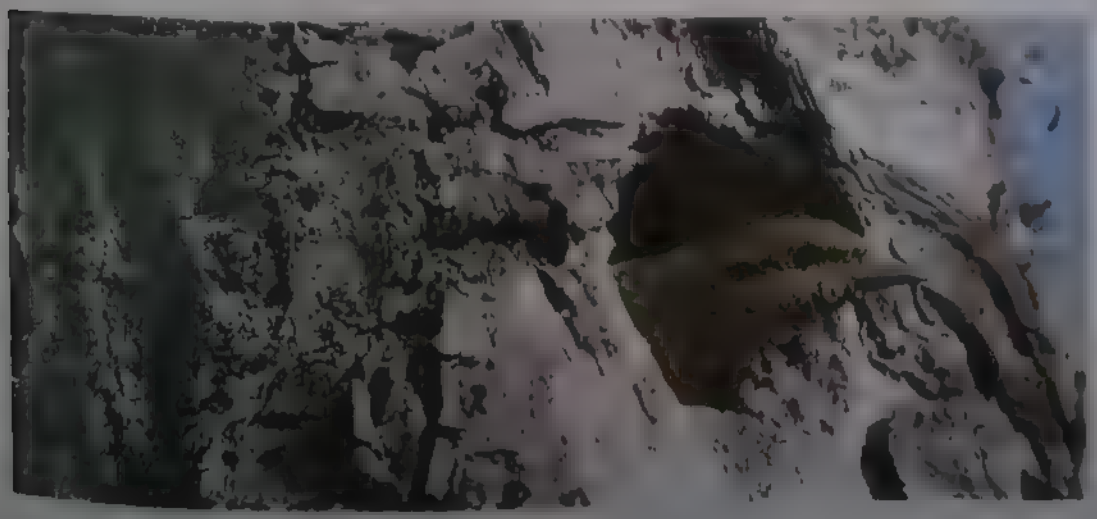
Compared with its relatives, the wryneck lacks bright plumage, but even so it has a distinctive appearance, being rather elongated in shape, slow in movement on the ground or in a tree, and lumbering in flight. Its plumage is a rich mixture of finely striped browns, buffs and greys, and in flight the long tail shows several dark bars.

Snake-like bird As it creeps about slowly among the branches, or on the ground, the wryneck's horizontal posture and writhing neck movements are very reminiscent of a grey-brown snake. The name 'wry-neck' relates to the way in which it extends its neck and twists its head through improbable angles. Often when it does this it raises the feathers on its head to the accompaniment of a loud, hissing call, and this strange combination has given rise to the colloquial name 'snake-bird'.

Causes of the decline Several likely causes have been suggested for the decline of the wryneck. The birds favour areas of short-cropped grassland with scattered large trees, large gardens, old orchards, parkland and the edges of commons or sandy heaths. But all of these are shrinking habitats: grassland is now either left ungrazed, in which case it is invaded by scrub, or it is managed commercially, being heavily fertilised and quickly mown. The result is a great reduction in the numbers of ants in these habitats. Economic pressures, too, have reduced the acreage of parkland, and changed the face of our orchards: no longer are massive old trees with holes tolerated. Lastly, of all habitats, heathland is regarded as currently under most pressure from agricultural reclamation.

It is known, however, that the decline started long before these habitats came under pressure, and certainly before pesticide pollution could have played a part. Perhaps the most likely explanation is that subtle climatic changes have rendered Britain – always on the edge of the wryneck's range – less suitable.





EUCALYPTS IN BRITAIN

Among the few trees from Australia that can survive the rigours of the British winter are the eucalypts, a group of slender, graceful trees, often with highly attractive foliage and flowers. Several species can now be seen growing outdoors in Britain.

The eucalypts belong to a large genus of some 500 species, most of which come from Australia. They first became known to western science in 1770 when Joseph Banks and Daniel Carl Solander, on Captain Cook's *Endeavour* voyage, collected *Eucalyptus gummifera* from the east coast of Australia. The name *Eucalyptus* means 'well covered' and refers to their curious flower buds. These consist of a structure called an operculum formed from modified sepals and petals, inside which are the style and numerous stamens. The flowers open by shedding the lid-like operculum to expose the floral parts. The stamens are the conspicuous part of the flower and are sometimes brightly coloured.

Above: One of the hardiest eucalypts in this country is the snow gum–perhaps due to the fact that, in its native Australia, it grows as far up as the snow line.

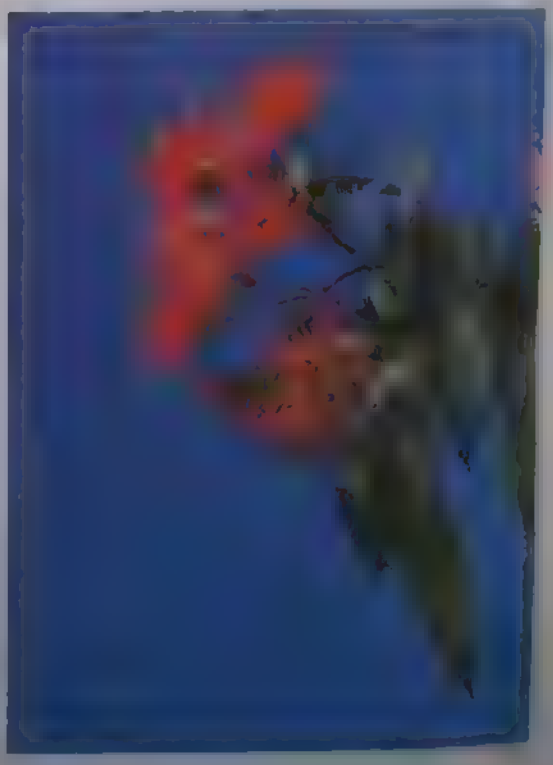
Right: The most conspicuous part of a eucalypt flower is the cluster of stamens and style, which are bright red in this species. These protrude beyond the cone-shaped operculum, inside which are copious supplies of nectar to attract pollinators.

Eucalypts in Europe The first eucalypt to be grown in Europe was the Tasmanian blue gum (*E. globulus*), seeds of which were sent from Australia to Paris in 1804. A few years later it was introduced to Britain and initial trials proved very successful. However, they succumbed to the first severe winter. Despite this, there was a craze for planting the tree during Victorian times, and some large individuals still survive in parts of southern Ireland, Tresco Abbey in the Scillies, and Sussex.

The introduction of the cider gum (*E. gunnii*) in 1846 proved far more successful. Indeed, the first batch of seed planted in Britain gave rise to the famous specimen at Wittinghame Castle which, a century after being planted, had a girth of 7m (23ft) and reached 29m (95ft) high. The success of the cider gum in Britain can be attributed to the fact that it grows naturally in subalpine areas of Tasmania, whose climate comes closer to that of Britain than does any other part of Australia.

Today within the British Isles most eucalypts are grown as ornamental trees in gardens, though the Forestry Commission are carrying out a small number of trials on the hardiness of new hybrids and varieties. There is great enthusiasm among many gardeners for the cultivation of eucalypts, despite the many tales of woe published in the gardening literature after the harsh winters of 1947, 1963 and 1979–trees being cut back to the trunk or the ground by the sharp frosts. Some trees were killed outright. About 40 or so species of *Eucalyptus* have been grown successfully in this country, though only about six or seven are hardy enough to be cultivated regularly.

Cider gum Easily the most widely grown species of eucalypt in Britain is the cider gum



Indeed, it is the only species of any size to be seen in eastern England and Scotland, some specimens reaching a heig[ht] of 30m (100ft). Many trees have survived harsh winters, even temperatures as low as −17 C (0 F).

The cider gum can be recognised by its smooth green and white bark. In [eu]calypts, the leaves of a young tree [are] different in shape from those on the adult tree and the cider gum is no exception. Its juvenile leaves are elliptical to oval and green with a bluish tinge. The adult leaves, however, are lance-shaped. The flowers are borne in groups of three and are somewhat greenish in bud. When they open around July they reveal their pale stamens.

Snow gums and peppermints One of the more interesting eucalypts found in Britain is the snow gum (*E. niphophila* also known as *E pauciflora*), which has brilliant bluish-white (sometimes reddish-brown) stems and branches. Its shoots are yellow at first and then dark red or violet. The adult leaves are initially red but unfold orange or brown and finally turn grey-green with red margins. It flowers copiously, each inflorescence consisting of between five and fifteen white flowers borne on thick stems in umbel-shaped bunches. The snow gum rarely grows to a height greater than 6m (20ft) in this country.

Also reaching to about the same height is the Mt Wellington peppermint (*E. coccifera*). This tree is particularly hardy in Britain and survives severe winters well if growing in a sheltered garden. The inflorescence usually bears three small flowers, though there may be as many as seven. Seen from a distance the flowers appear as a white fuzz on the tree, though the main ornamental attraction of this species comes from its pale greyish, twisting trunk and its tiny, pale greenish-blue leaves.

Other species One of the few eucalypts that grow really well in Britain is the small-leaved gum (*E. parvifolia*), yet surprisingly it is still quite rare. The oldest known specimen mentioned in the literature is only about 30 years old. This species can reach a height of 9m (30ft) and has smooth dull grey, lead-coloured stems. Its usefulness as a tree for borders and shrubberies is enhanced by its liking of poor, heathy soils.

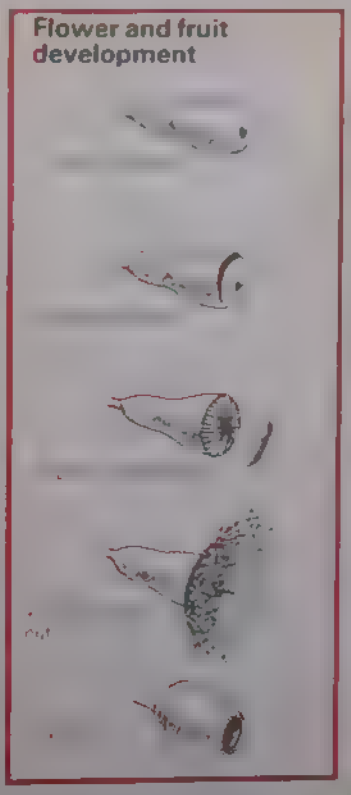
The silver top (*E. nitens*) was introduced to Britain in 1965 but unfortunately most specimens were killed completely or cut back to the ground by the harsh winter of 1979.

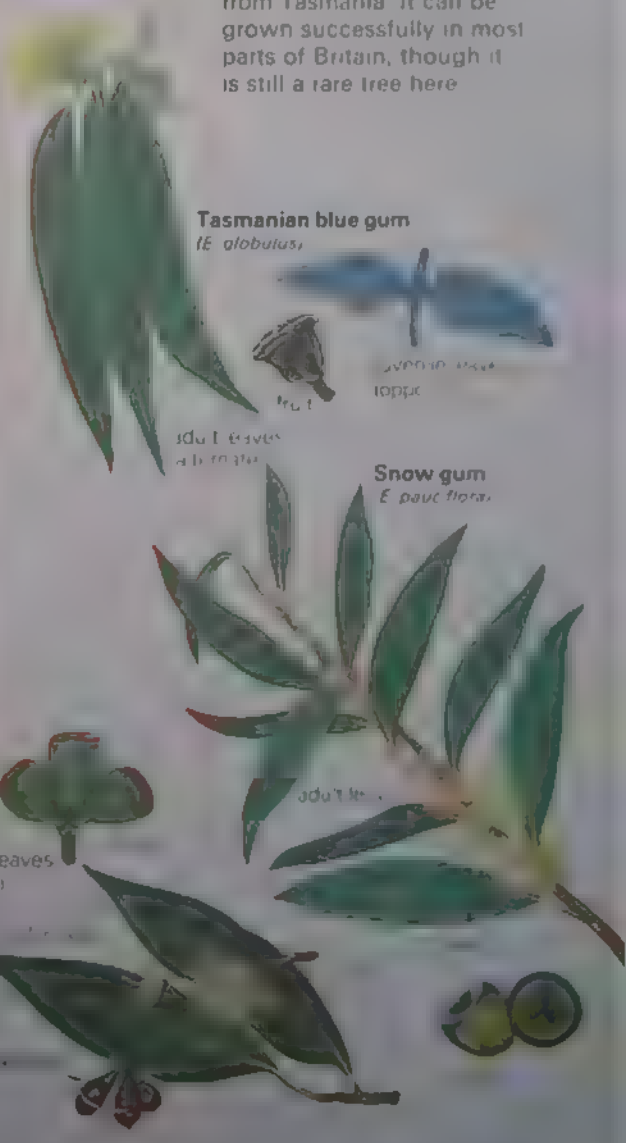
The urn-fruited gum (*E. urnigera*) grows to a height of 15m (50ft) and has a smooth bark mottled red and brown. It is easily recognised by its abundant urn-shaped fruit capsules, after which it is named.

It is unfortunate that, though many eucalypts have brightly coloured flowers, those of the hardiest species tend to be white and often very insignificant. In recent years, however, the spectacular red-flowered gum (*E. ficifolia*) has reportedly survived cold winters in Tresco Abbey, Penzance, Devon and Dublin.

Looking at eucalypts

Above The pale green [leaves], [flowers] and [fruit] of the Mt Wellington peppermint, a less well known eucalypt from Tasmania. It can be grown successfully in most parts of Britain, though it is still a rare tree here.





THE NEW FOREST'S ANNUAL PONY DRIFT

During late summer and early autumn the tranquility of the New Forest is disrupted by the annual pony 'drifts'. Areas of the Forest echo to the sound of galloping hooves, whinnying ponies and shouting riders, as the Commoners round up their ponies into strategically placed wooden pounds.

Left: A mare and her foal exercising in the spring sun at Lyndhurst in the New Forest. For most of the year the ponies are free to roam out on the Forest almost at will, along with cattle and pigs that, according to ancient right, the Commoners may turn out to graze there

The annual pony drifts are part of the traditional life of the New Forest. They are organised in August and September by the Agisters–four men appointed by the New Forest Verderers to look after the overall welfare of 'commonable' animals–those that the Commoners may, according to ancient rights vested in the land they occupy, turn out to graze on the Forest.

Organisation Each Agister tells the riders of the approximate location of the first bunch of ponies to be drifted and arranges for those on foot (known only more or less appropriately as 'walkers' since they often have to move very quickly) to station themselves near the wooden pound to prevent any ponies breaking away from the driven herd.

Once out in the Forest the riders spread out behind small groups of ponies and begin to drive them in. The moment the colt-hunters, as the riders are called, appear on the scene, the mares' heads go up and they are off at a brisk pace, usually heading for deep woodland or tall clumps of thick gorse where they can be lost in no time at all.

Although the Agister and the Commoners know the Forest intimately, even they cannot

Above and right: August, and the start of the annual drift when the season's foals are old enough to gallop with the mares. In theory, if the drift is well organised it should be quite straightforward and take place at a relatively leisurely pace. In practice it is usually an exciting, fast riding and quite often dangerous pastime. Most of the wily old mares have lived out on the Forest all their lives, and seem to know instinctively the difference between the hundreds of riders who use the Forest for pleasure and those who are bent on rounding them up and perhaps curtailing their freedom–if only temporarily.

Above. The annual drift is a good opportunity to treat the ponies with worming preparations—a medicated syrup which is syringed into the animal's mouth

Below. Some of the ponies which have been rounded up are sold at the local Beaulieu Road pony sale which takes place after the drifts

always winkle out animals which have taken refuge in the deep Forest, and many a hair raising gallop across the treacherous going has resulted in a crashing fall which is treated with derision rather than sympathy by other riders. Within a few minutes on one oft-recounted drift the Agister's pony went head over heels over a hidden drain, a Commoner's wife shot off her pony into a bog, the rider who went after her loose pony fell off and was kicked in the face, and a young lad was swept off his pony as they galloped under a low

[illegible] the [illegible] tread [illegible] run, and help the [illegible] mass [illegible] excited animals into the safety of the pound. It all seems to happen at high speed over a few minutes: one moment the ponies are just specks on the horizon, the next they are surging towards the pound. Quick thinking is the order of the day if they are not all to be lost again.

Although the drifts enable the Commoners to catch those ponies they want to sell, this is only one of their functions. Under Forest Law the Commoners must pay a 'marking' fee to the Verderers for the grazing of their animals. The Agisters collect the fees, issue a 'receipt' for them and check how many ponies each Commoner has turned out in each area.

The drifts are also the one occasion in the year when the ponies can be caught and handled; for the remainder of the year they roam out on the Forest, and it is not easy to catch individual animals. Once the ponies are in the pound their owners can inspect them for illness or injury and treat them with worming preparations in an attempt to diminish the very heavy infestation most of them carry. It is also an opportunity to brand the foals that will be left running out on the Forest. All the mares will have been branded in previous years, but the foals which are not to be sold must by law be marked with the owner's registered brand before they are released on to the Forest again to develop into brood mares or potential stallions.

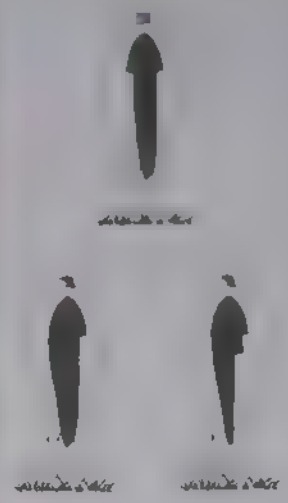
Catching single ponies Sometimes a Commoner needs to catch up an individual animal. It is clearly not practical to conduct a drift so a variety of other methods are used, usually involving two riders.

Working as a pair, they cut the required pony out from the herd and as it gallops away the two riders come alongside until one is close enough to grab its tail and give it a quick twist, bringing the animal down. The rider then jumps off his pony and quickly sits on the colt's head, while his partner, having caught the now riderless pony, puts a rope round the colt's neck and it is then taken back to a trailer or pound.

On other occasions one rider grabs the colt's tail to slow it down while his partner endeavours to get a rope round its neck. The methods sound a little rough and ready, but they are invariably carried out with skill, and the only thing likely to be hurt is the rider who jumps off his pony and lands heavily on the

Owning New Forest ponies

Tail marks



Tail marking in the pound (far left) The Agister climbs among the animals checking their brands and at the same time he ta marks each one as a form of receipt for the ... s annual fee The tail hairs are cut with a large pair of scissors into distinctive patterns–each Agister having his own pattern according to which area of the Forest he patrols The tail marks thus not only show that the fee has been paid but also in which area of the Forest the pony has been turned out While this is taking place, the individual branding irons are heating up over a small wood fire for the next stage of the annual pony drift

Brand marks

ground

A third method which requires great courage and impeccable timing is sometimes used. One rider gallops alongside the pony and at precisely the right moment gets one arm round its neck; then, still travelling at some speed, he jumps off his pony and manages to get both arms round the other animal's neck and bring it down, all the while holding on to the reins of his own pony. The other rider then slips a rope round the colt's neck. Incidents do of course occur: one of the most unlikely happened a few years ago when a rider leapt off his own pony in the usual fashion, and at the same time out of the Wellingtons he was wearing, leaving them standing upright in the stirrups

Legends Colt-hunting legends are legion One of the best concerns a pony named (appropriately) Mockbeggar Outlaw. Using all the wiles of his native breed, Outlaw managed to evade capture on drifts for an astonishing eight years. In spite of his diminutive size of only 12.3 hands (130cm/51in) he out-galloped and out-witted the Commoners time and again. Finally they mounted a concerted effort to capture him and two riders, both mounted on half-bred ponies that could really gallop at speed, finally caught up with him. With one on either side they kept up with Outlaw and after a hazardous flat-out gallop across the rough going of the Forest they managed to drive him into a pound. Once confined, he put up a terrific fight to get out, endeavouring to jump the high sides of the enclosure, but finally he had to concede defeat. The Commoners estimated that the little pony had covered at least four miles at a break-neck gallop before being caught. Strangely enough, once he had been caught, he never again tried to elude the Commoners, and came in regularly in a peaceful way in subsequent drifts

So the drifts go on, year after year, without much change. However the increased traffic in the Forest has finally forced one Agister to change his method of taking some of his colts home. At the end of the drift he used to dismount from his pony, unsaddle it, attach a colt each side of it by ropes, give it a slap on the rump and set it off in the direction of home, while he went back by Land Rover. All three invariably turned up at the holding some little time later. Those were the days -today it would be too dangerous to allow the ponies to go unaccompanied along the roads of the Forest.

Below: Branding a colt (Commoners call all foals colts'–referring to fillies as colt foals and colts as horse colts) is no easy task. It frequently requires the combined efforts of three or four men to hold the struggling little animal up against the side of the pound while the branding iron is quickly applied, usually on the nearside shoulder. All the mares will have been branded in previous years Each Commoner has his own individual brand

MACKEREL: A FISH IN DEMAND

The mackerel, a popular sporting fish for seaside holiday makers, has in the past few years assumed a new level of importance. Since the decline of herring stocks, it has become the object of the largest single-species fishery in Britain.

Mackerel are firm-bodied fishes with a striking appearance. They are streamlined in shape and patterned with dark wavy markings on their greenish-blue backs. Their bellies are white, with tinges of pink and gold. These features tell us something about their habits, for they are fast-swimming fishes that live in shoals in midwater, their camouflaged upper coloration undoubtedly contributing to their defence against large predators such as gannets, sharks, dolphins and the smaller species of whales.

Off the coasts of the British Isles, mackerel are near the northern limit of their range, for the mackerel family (Scombridae) as a group are mostly subtropical in their distribution.

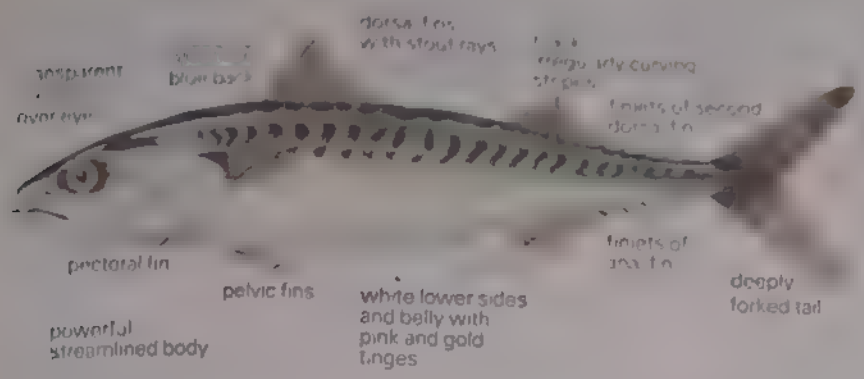
Above Mackerel can grow to a large size, specimens approaching 70cm (28in) in length having been reported The normal size for mackerel caught off our coasts, however, is from 30-50cm (12-20in) and this is the size of the fishes shown here. The weight of an individual mackerel increases with age and varies with the time of year, but the average weight of fishes caught around Britain is about 260g (10oz). The age of most mackerel caught is 2-4 years

Mackerel in British waters In the north-east Atlantic mackerel spawn in spring from about March to July, each female spawning from 100,000 to one million eggs in batches, the total number depending on her size. The spherical eggs, which are 1.2mm in diameter, and which contain an oil globule for buoyancy, are spawned over deep water (120-500m, 60-250 fathoms or more). They drift for three to six days depending on the ambient temperature, until they hatch into transparent larvae about 3.5mm long

Separate stocks Spawning of mackerel is concentrated in two areas: one in the central part of the North Sea, the other in the south-western approaches, from the Bay of Biscay along the edge of the Continental shelf to the west of Ireland. Although these two populations of mackerel are similar, if not identical, in their biology, they are considered to be separate stocks: there is no evidence that a significant proportion of mackerel from one area ever spawns in the other.

Small mackerel Young mackerel are distributed over large areas, mainly closer to land than the spawning areas. Important nursery areas are the Celtic Sea south of Ireland and the eastern part of the North Sea. At about two years of age, when they are about 25cm (10in) long, they are commonly found close to the British coasts. In particular, they congregate in winter off the coast of Cornwall, where they are caught by local fishermen

Mackerel identification features



operating from small boats close inshore.

Fully grown fishes Mackerel mature into adults at an age of 2-4 years, and the adults are migratory. In spring those that spawn west of the British Isles move offshore to the spawning areas. After spawning, they migrate northwards, the larger mackerel apparently travelling faster and further than the smaller ones. Considerable numbers reach the Norwegian Sea north of the Shetlands, and some continue into the northern part of the North Sea. In some years small numbers even reach Iceland. During the summer, from about June to August, the two stocks of mackerel mix in the feeding areas to the north of Britain and in the northern North Sea.

Mackerel have a reputation as scavengers, living on waste or dead material. Nothing could be further from the truth, however, for they actively seek living food, mostly feeding at considerable distances from land. Their food consists of planktonic animals such as euphausiids (small relatives of krill), while recent research has shown that small fishes (mainly sandeels) form a larger proportion of their diet than was hitherto thought.

Returning south In the period from late August to October the adult mackerel of the western stock cease feeding and migrate south along the coasts of western Scotland. These well-grown fishes form the basis of the important Minch fishery, which is based at Ullapool and, to a smaller extent, at Mallaig and Stornoway. As the autumn progresses, the mackerel are caught progressively further south, reaching the west of Ireland about November, and in midwinter some join the overwintering shoals of younger mackerel along the Cornish coast

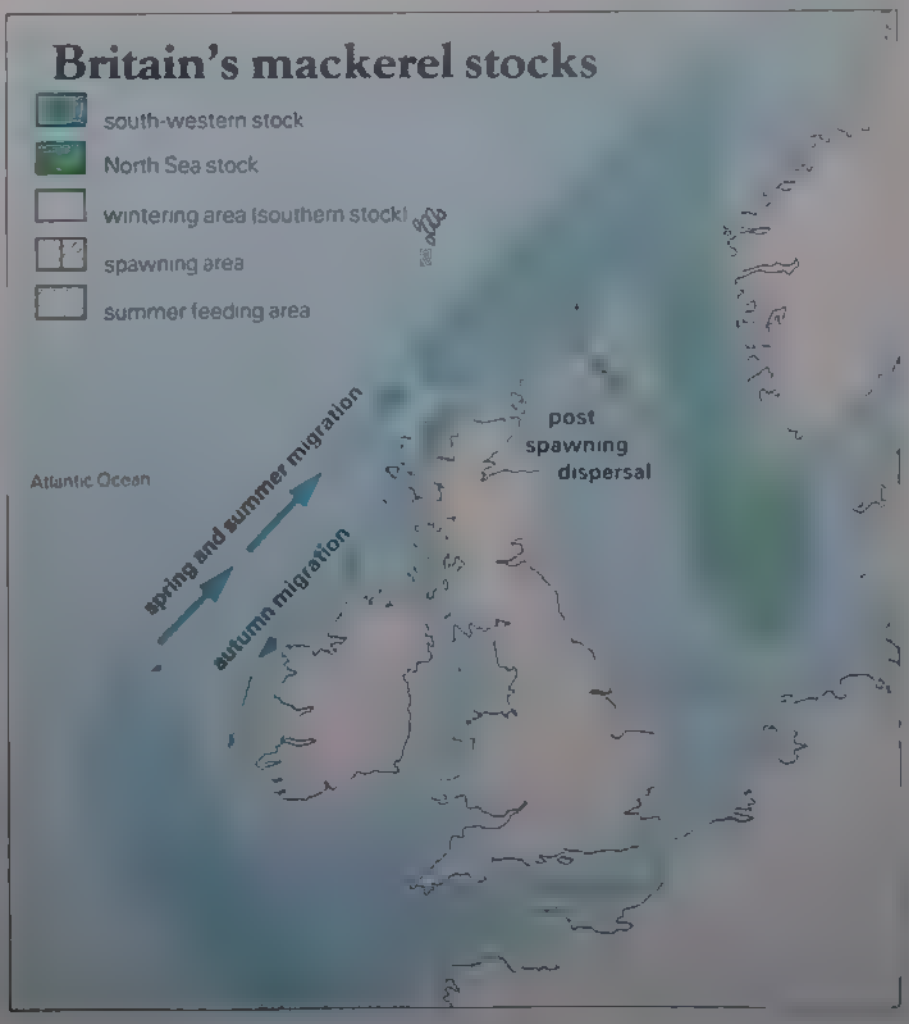
Increased catches Fishing for mackerel around the coasts of Britain has increased rapidly in recent years, largely as a result of the fishermen's need to find an alternative to herring as the stocks of that species declined At first, the home market for mackerel was slow to develop, and the catchers had to rely mostly on visiting factory vessels (known as 'klondykers') from the eastern bloc countries to buy their catches There is now, however, a considerable demand especially for smoked alternative to the high-priced smoked salmon in hotels and restaurants

Landings of mackerel in Britain (including landings trans-shipped to the 'klondykers') rose from 9000 tonnes in 1972 to 350,000 tonnes in 1979, since when they have dropped with the imposition of controls on the total allowable catch In addition to British ships, vessels from several European countries fish intensively for mackerel This has resulted in depletion of the stocks The North Sea stock in particular has declined considerably, since the peak catch of 930,000 tonnes from that area was taken in 1967. The decline in this stock since the early 1970s is partly due to fishing and partly to the poor survival of young mackerel from each year's spawning since 1969. This explains the predominance of 14-year-olds in this stock during 1983

While the western stock is in a much healthier state it, too, is decreasing in size, and only effective catch limitation seems likely to halt the decline.

Besides controlling the total level of the catch, other conservation regulations which have been introduced are designed to reduce the catching of small, immature mackerel. An area off the Cornish coast, for example, has been closed to most types of mackerel fishing for that part of the year when the fish caught tend to be small. There is some hope that such measures will halt the decline

Below: A simplified map of the main distribution and migration of mackerel in the north-eastern Atlantic While the overall pattern is shown, individuals may occur at almost any point around Britain at the 'wrong' time The two stocks overwinter and spawn in their respective areas, moving north in summer to feed; the stocks are partially mixed in summer. No wintering area is shown for the North Sea mackerel, as less is known about the migrations of this stock



GOLDEN STABLE WOOD

Set in the lovely countryside of Kent, Golden Stable Wood is both farm and nature reserve. Its aim is to show that commercial farming and wildlife need not be mutually exclusive.

North Frith Farm is situated 3.2km (two miles) north of Tonbridge in a beautiful part of the Weald of Kent, and covers 200ha (500 acres). Of this, 80ha (200 acres) is woodland, and the remainder is now divided into 18 fields of various shapes and sizes. Both livestock and crops are grown. In 1983 the farm harvested about 40ha (100 acres) of wheat, barley and oats, and a further 20ha (50 acres) of hay. Some 450 sheep and their lambs and 90 cattle grazed the remaining fields and, in the barns, a total of 2000 turkeys were reared for Christmas.

Running the farm The main entrance to the farm lies on the southern boundary and from here a long, straight, hedge-lined drive runs northwards towards the farm buildings. Throughout the summer these hedges are allowed to grow unchecked, thus providing ideal nesting sites for the yellowhammers and bullfinches that feed on the wild flowers. Small mammals abound in the long grass of the verges and in spring cow parsley clothes both sides with its delicate lace-like blooms.

The heavy clay soils are not ideal for cereal growing, and most of the grain is sold through a corn merchant for animal feed. In 1983 the exceptions were a single field of spring wheat (a high-quality bread-making variety called Broom), and the field of winter oats which was sold to a breakfast cereal producer. Land's End Field proved to be appropriately named

diverse subjects as fa and deer, turkey-rearing and kingfishers, farm machine and moth traps, and cerea growing and or hid spotting. While wildlife demonstrably thrives at North Frith, a larg and uncontrolled influx of people could have disastr consequences, so a full-time resident warden has been appointed to run the centr and to guide visitors round the farm. Old maps show that one of the largest and mos attractive areas of woodland has long been known as Golden Stable Wood and i is from this that the centre takes its name.

Below: Periwinkles – one of the many flower species to be seen and enjoyed on the reserve

when it became apparent that it was far too waterlogged to support the tractors at sowing time. If nothing else, the experience proved yet again how dependent farming can be on the weather

Summer is the busiest time of year and full use is made of the long hours of daylight Plenty of rain early in the year, followed by a warm dry summer, is ideal for haymaking. By mid-June the grass in Park Field is usually ready to be cut, and in early July about 1000 bales from this field alone are stacked in barns.

When the grass in the fields stops growing in winter, a plentiful supply of hay is essential for the sheep. Two main breeds are kept: pure Clun (derived from a Clun ram and a Clun ewe), and Scotch half-breds (from a Border Leicester ram and a Cheviot ewe). The Clun sheep have black faces, black legs and slightly off-white wool extending on to their foreheads. In contrast, the Scotch half-breds have white faces, white legs and rather whiter wool (but not extending on to the forehead). At lambing time, from February to April, the ewes are brought inside. Here they can be watched and cared for until their lambs are strong enough to go out to the fields.

The yards used for lambing were originally built for bullocks and dairy cows. Nowadays, however, the cattle that graze at North Frith are not owned by the farm and only stay from late spring to the autumn. Some are Friesians, some Herefords and the remainder are Friesian Hereford crosses

The last main product of the farm is turkeys. This works well since further use can be made of the lambing yards. In Britain turkey sales boom just before Christmas each year, so the aim is to capitalise on this market Accordingly 1000 one-day-old turkey chicks are bought in mid-June and a further 1000 in July and August. Fed on protein-rich pellets, they grow at a rapid rate until, in early December, the first are ready to be sold

Woodland management Much of the woodland is actively managed for its wood, and a single forester coppices and thins the plantations at regular intervals. Several types of plantations are represented. Sweet chestnut and hornbeam are grown as coppice, often beneath oak standards. There are pure plantations of spruce, pine and larch, and

Above: Proof of the variety of moths on the farm is often demonstrated by running a moth trap overnight. Poplar hawk-moths (shown here) and elephant hawk-moths garden tiger moths and peach blossom moths are common. Among the butterflies, orange tips are some of the first to appear Later in the year you'll find meadow browns gatekeepers, large, small and Essex skippers, commas clouded yellows and many others

Below: Greater stitchwort flourishes in the hedgerows on the farm

others where these alternate in rows with oaks of the same age, in their search for light, both soft and hardwoods grow tall and straight. While the softwoods are worth felling after about 60-80 years, the oaks must be left for about 150 years.

For the wildlife, the most important aspect of the woodland at North Frith is that there are very few extensive plantations. There is always a mixture of tree species and heights within sight, and a stroll along some of the many well-kept rides reveals a healthy scattering of mature and even decaying trees.

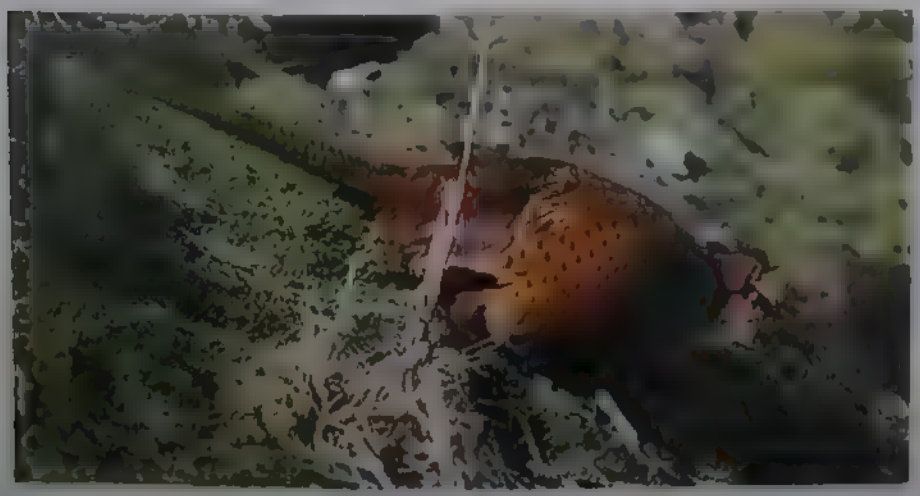
At least 20 species of mammals have been seen at Golden Stable Wood. By far the largest is the Japanese Sika deer which was introduced some years ago. Their sheep-like but rather more pointed tracks are everywhere, but an early morning walk is the only sure way of finding these handsome animals. Including the calves born in 1983, there may now be approaching 30 of them. Mice, voles and shrews can often be heard among the vegetation, and badgers have a sett in the woodland. Both stoats and weasels are among the predators.

Freshwater, hedges and nest boxes Freshwater habitats at North Frith Farm include a large and attractive lake, a long winding stream, 15 ponds and a marshy area. Even before the Golden Stable Wood project was started, these habitats were considered as assets rather than hindrances. The ponds, for example, complete with water plantain and figwort, are maintained as such, and the stream will continue to support its celandines, kingcups and purple loosestrife. Thistles, foxgloves and rosebay willowherb are left to adorn the field edges and primroses to add colour to the woodland rides.

The lake was dug in the 1880s to provide a refuge for wildfowl and so to increase the number of ducks and geese for shooting. Some shooting still continues, but this is strictly controlled, and the farm manager rears about 50 mallard ducklings each year to make good the losses. Greylags, Canada geese and little grebes are among the nearly 60 species of breeding birds on the farm, and kingfishers and herons can often be seen. In

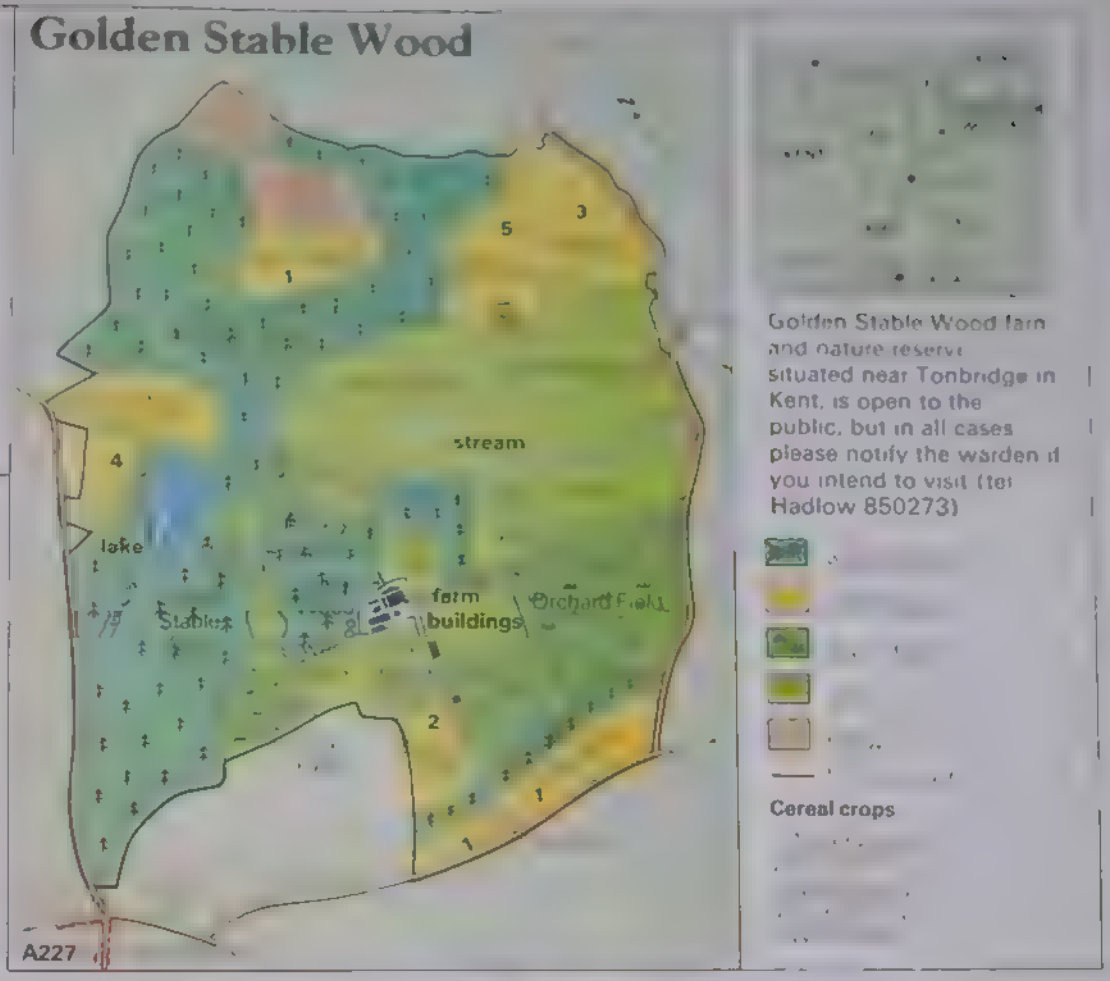
Above: The comma butterfly is one species to look for on the reserve. A stream runs through the farm (right) and the wild flowers growing along it, such as the cuckoo flower, are allowed to flourish. The brightly coloured yellowhammer (below right) can be found in the hedgerows bordering the drive leading to the farm.

Below: Pheasants are reared on the farm and released into enclosures in the woods such is the number of foxes that very few clutches laid by wild birds survive for long. Despite the precautions taken, foxes kill several lambs each year and for this reason some have to be shot. Rats around the farm buildings are also controlled, but beyond this most animals are left alone. Only the least toxic sprays are used, and when insecticides are necessary, granular systemics are used where possible. Seed is often dressed with chemicals poisonous to birds, so the farm staff always try to ensure it is properly covered by soil when sown.



One important facility that Golden Stable Wood can offer is a display centre which is being set up in the old oast-house. The roof was badly bomb damaged during the War and the cowls have been capped off. Now it has a new future as a day base for excursions into the woodland and around the farm. It is hoped that its bats and house martins will remain in the oast-house for all to see.

Below. On North Frith Farm the Scotch half-bred sheep (a lamb and a ewe are shown here), known for their good quality meat and wool, are crossed with a Suffolk Down ram to produce quick-growing lambs for the market. The ewes of the other breed of sheep on the farm, the Clun, are mated with either a Clun ram or a Dorset Down ram. Ewe lambs from the former (that is, the ones which are pure Clun) are kept for stock replacement, but the rest are sent to the market for meat.



Golden Stable Wood farm and nature reserve situated near Tonbridge in Kent, is open to the public, but in all cases please notify the warden if you intend to visit (tel Hadlow 850273)

the woodland, all three woodpeckers, six species of warblers and even a woodcock can be found.

Like the ponds, the farm hedges are now conserved. Most of the fields are bordered by thick hedges coupled with a few tall trees. These provide food and nesting cover for the birds and also much welcome shade for the sheep in summer.

In recent years about 50 nest boxes have been erected in the woodland, and most are occupied each spring. In 1983, nearly 200 nestlings fledged from the boxes, mostly blue and great tits, but also some coal tits.

Courses, holidays and excursions The Golden Stable Wood project has enormous potential. Adjacent to the farm is a Christian holiday centre where groups of children or adults can be accommodated for several days at a time. Schools can run field courses and the warden has planned a series of wildlife holidays designed to open people's eyes to the wonders of nature. Badger and deer watching, bird ringing, moth and small mammal trapping, plant identification, pond dipping and numerous other activities are listed for visitors, and they will even be able to help in management tasks like the building of bridges and hides, if they wish.

For further information write to: N J Matthews, The Pink Cottage, North Frith Farm, Ashes Lane, Hadlow, Tonbridge, Kent.

INDUSTRIAL MELANISM

Wildlife is threatened by industrialisation, but a few species have adapted to soot-covered environments by developing a darker colouring –industrial melanism.

Above: Only a few woodland species of moth have successfully adapted to the spread of urbanisation Among them is the waved umber moth, a member of the geometer family. As a species which rests by day on tree trunks, it has to adopt a suitable colouring to conceal itself from birds. The normal form (above), found in rural areas, is pale with brown wavy markings, but the melanic form (below) is distinctly darker to blend with the soot-blackened tree trunks of urban areas. This black form occurs plentifully in north and east London

Melanism is a term used to describe the occurrence, of dark coloured or black individuals in a species which is normally a lighter colour. It is frequently seen in insects, often under natural conditions. In the north of Scotland, for instance, a dark coloured variety of the oak eggar moth occurs on wet peaty moorland which produces a dark environment. Melanistic varieties of moths also occur in pine forests, probably as a response to the dark colours of tree bark on which the moths rest by day

Industrial melanism, however, is a special case–the dark background on which the animals are trying to conceal themselves is produced by atmospheric pollution. Pollution affects trees in two ways; it kills lichen growing on their trunks, and it causes deposition of soot which blackens the bark of trunks and branches. The Industrial Revolution first produced this effect in Britain.

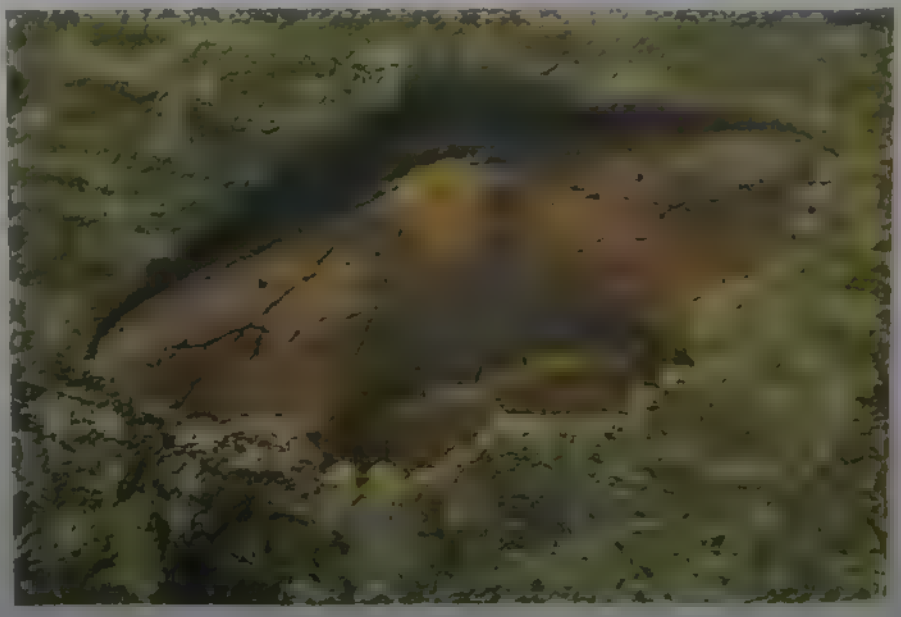
The peppered moth Already known to collectors in England in the 1770s, the peppered moth's name refers to the black

[illegible] responded [illegible] black populations In south-west [illegible] and the north and west of Scotland how[illegible] the black form remained absent, and al[illegible] south coast the speckled form was, an[illegible] much more common than th[illegible]

Researching melanism Through[illegible] half of this century the association of the black peppered moth with smoke-polluted area became clear, and the rather obvious explanation of this–that black moths were protected from predation by birds when they rested on a black background–was suggested

In 1952 Dr Kettlewell–a geneticist from Oxford–began a long, painstaking and entirely successful programme of research. It was based on the theory that the establishment of black peppered moths was due to natural selection of an originally black mutation in an environment where the normal speckled form, resting on sooty tree trunks and branches, was conspicuous, while the black form was well concealed. (In unpolluted rural areas the speckled form is well protected when at rest on lichened bark.) The selective agent was assumed to be predation by birds which hunt their prey by sight

In one of his best known experiments Dr Kettlewell chose a wood near Birmingham in which the trees were blackened by industrial pollution. While collecting in the wood he established that 90% of the naturally occurring moths were black. He also found an unpolluted wood in Dorset in which 95% were speckled. He then bred large numbers of both



forms and released half of the black and half of the speckled variet

A few days after releasing them he oper ted moth traps in order to recaptu as many of the moths as possible. I Dorset wood the percentage recaptured of t total of released black moths was just half that of the speckled ones. In the Birmingham wood, however, the percentages were almost exactly reversed. Black moths resting on the lichen-covered trees in Dorset had been found by their predators twice as readily as speckled ones, but on the soot-blackened trunks near Birmingham the pale speckled ones were at an equal disadvantage

Selective predators Dr Kettlewell's experiment, however, gave no indications of what predators were involved in this selective elimination of black and speckled moths. To discover this he placed moths of both types on lichened and blackened trunks, and watched to see if any insectivorous animals found them. This required a great deal of patience, but he was rewarded by observing birds finding and devouring the moths. The birds took them selectively, mostly finding moths which were resting on the 'wrong' background

Dr Kettlewell's research on the peppered moth is of great importance since it provides a demonstration of evolution by natural selection, actually in the course of taking place, and doing so much more rapidly than is usual in nature. The speed of this evolutionary change is due, of course, to the very rapid environmental change (industrialisation) which brought it about.

Black genes Dr Kettlewell also bred peppered moths in captivity on a vast scale in order to investigate their heredity and genetics. He found that there are two genetically distinct dark forms: the melanic form *carbonaria*, which is abundant and fairly black, and the other form *insularia*, which is less common and black with faint pale speckling.

He also found that both black forms are

Melanic species

oak eggar mot
two different forms the
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industrialisation, however
the dark form be
much more common
showing that the moth
was also industrially
melanic

Oak eggar moth

Oak eggar moth
(Lasiocampa quercus)

The two-spot ladybird is another case of industrial melanism. The normal form is red with two black spots, while the melanic form, common in the Birmingham area, is black with four red spots

Two-spot ladybird

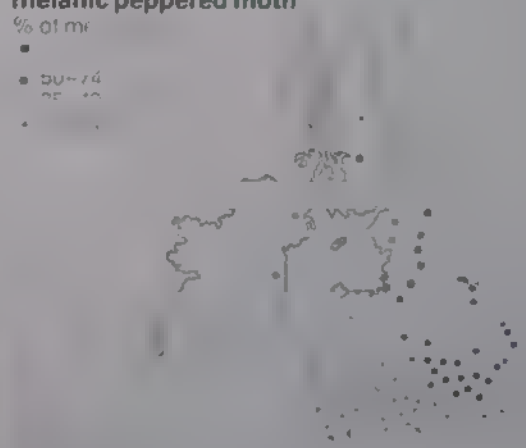
The little **zebra** or **jumping spider** is normally black with white stripes, but in industrial areas it is entirely black, apart from its legs.

Zebra spider

Right. Two maps showing the occurrence of melanic peppered moths and two-spot ladybirds in Britain. The melanic forms are predominant in the industrial regions—the London area, the West Midlands, Lancashire and the Scottish Lowlands.

Below: A melanic figure of eighty moth.

Distribution of melanic peppered moth



Distribution of melanic two-spot ladybird

genetically dominant to the normal speckled form; that is to say, a moth that has inherited a 'black' gene from one parent and a 'speckled' gene from the other will be black, not intermediate in coloration

Other melanistic moths As many as a hundred British moth species have been reported as showing signs of industrial melanism. One such species is the pale brindled beauty, normally a pale brownish-grey moth. It has more than one melanic form, and its distribution differs from that of the black peppered moths. Although both species are black in urban areas, you can also find black pale brindled beauties in the rural parts of Scotland and South Wales where no melanic peppered moths occur. In East Anglia most peppered moths are black, but pale brindled beauties are their normal colour

Little seems to be known of the black pale brindled beauties before the Industrial Revolution, but this species may have a natural tendency to melanism, which becomes established by natural selection in industrial areas.

The oak eggar has a northern natural melanic (it is naturally dark in Scotland), although it also has a black form on the Yorkshire moors, where the ground surface and heather are heavily polluted by industrial smoke. It does not live in urban districts, but the Yorkshire moorland dark form can be regarded as an industrial melanic (unlike its Scottish counterpart).

The case of the figure of eighty moth is interesting, as the melanic form seems to have migrated to this country from Continental Europe. It appeared in Holland and in the second quarter of this century, but was not seen in England until 1945. The normal brownish-grey colour is replaced by black.

Although the spread of urban conditions threatens most species of woodland moths, a few adapt to it well, feeding as larvae on trees in parks and suburban gardens. Among them are the brindled beauty, the waved umber and the sycamore moth. All these species rest by day on the bark of trees and, not surprisingly, have evolved melanic forms.

Black ladybirds Among insects other than moths, the best known case of industrial melanism is that of the two-spot ladybird. The normal form is red with two black spots, but the amount of red and black is naturally variable. However, in the industrial Midlands the prevalence of a black form ranges from 60% or 70% to 90%, and surely must be a case of industrial melanism

It is difficult to see how the beetles gain any advantage from being camouflaged though They are protected by distasteful body juices and their normal bright pattern is an example of warning coloration. It is possible that shiny black is also effective as a warning, so that the melanic ladybirds enjoy the double advantage of being difficult to find, and recognisable as nasty if they are discovered.

Zebra spider Outside the scope of insects, cases of industrial melanism appear to be rare. One example is the zebra or jumping spider Normally clearly marked with black and white stripes, it lives and hunts its prey on walls and tree trunks. Insectivores take this spider if they see it, and it is obviously to the spider's advantage not to be conspicuous. Just as in the peppered moth, a black and white normal form has been replaced by a black one in urban areas, so that the spider is almost invisible on the soot-stained walls and trees.

Above: The normal form (left) and melanic form (right) of the pale brindled beauty. This moth is on the wing in January, February and March, but you are only likely to see the male because the female is wingless

Below: Peppered moths resting on a wall. The one in the top left hand corner is melanistic while the other two are normal forms The peppered moth is probably the best known example of a species which has adopted melanism in urban areas. The first melanic peppered moths were reported in Manchester in 1848, and by 1895 nearly all of the city's peppered moths were melanic. This black variety soon established itself in all the large industrial areas, and also in the regions to the east where the westerly winds were blowing the smoke, and polluting the environment

PLUSIIDS: MOTHS WITH TOP-KNOTS

The plusiids are small, attractively adorned moths with such evocative names as the beautiful golden Y and the burnished brass. Some are indigenous, but others are migrants from the Continent which have only recently colonized these islands.

Some 20 plusiid moth species have been recognised in the British Isles; they are so-called because they belong to the Plusiinae a predominantly tropical sub-family of the Noctuidae family. The plusiids are mostly small or medium sized moths. Some are particularly attractive with glossy metallic-looking markings, although their most distinctive feature is the top-knot of hair-like scales which stands erect, just behind the moth's head on the thorax. Although all species fly at night, some may be encountered visiting flowers in the daytime.

The plusiids are a particularly interesting group of moths. Some are notable migrants which have been extending their breeding ranges in Europe during the last century one species, the golden plusia, has colonized much [illegible] the south a reverse of the usual situation

Migratory moths [illegible] plusiid species is the silver Y, a dark, medium sized moth deriving its name from the conspicuous silvery-white mark resembling a 'Y' on the centre of each forewing. Its forewings are usually a shade of shiny grey and are attractively marbled with a rich purplish-red colour. The hindwings, hidden when the moth is at rest, are dingy grey and bordered with a broad blackish band

The silver Y is a visitor to the British Isles Unlike most plusiids, it cannot survive our winters, either in the adult or the immature stages, although moths have occasionally been reported in Britain as late as December Each year, around the end of May, silver Y moths arrive in southern England, coming across the Channel from the Continent, and disperse throughout the country. This first wave of moths is followed by a second, much larger, immigration which normally arrives in early July and may continue right through the summer until September

There is an interesting difference between these two influxes, the moths of the first wave are sexually mature while the vast majority of the second wave are not. Thus it is only the first wave of moths which give rise to one or more British-bred generations. These British-bred moths emerge in late August and September so their arrival coincides with the second wave of immigrants from the Continent–a factor which explains the abundance of the silver Y in late summer

Good and bad years The fact that the majority of silver Y moths arrive with the second immigration rather than the first is accounted for by westerly weather movements which occur over northern Europe in the late summer These westerly movements can reach vast proportions in some years, and it is these years which are excellent for the silver Y moths This happened in both 1946 and 1947 the latter being a particularly good year for all migrant insects

Above: The tuft of hair-like scales just behind the moth's head is a distinguishing feature of all the plusiids This is the gold spot moth (*Plusia festucae*), a species of wetland habitats

Right: The plain golden Y (*Autographa jota*) is so named because of the golden metallic mark on its forewings. A common and widely distributed species it flies at night in June and July. The caterpillars are yellowish-green with white spots.

Golden plusia A remarkable moth is the golden plusia, which has succeeded in colonizing most of Britain in the last 95 years. Initially found only in the south-east, it rapidly extended its range northwards and westwards. The probable reason for this rapid colonization was the stimulus provided by the climatic amelioration (rise in temperatures) which began towards the end of the last century–a number of other insects and birds also extended their ranges north-west in Europe during this period.

The golden plusia's normal foodplants are larkspur and monkshood (cultivated plants) and so this species' caterpillars are most often found in gardens and parks–even in the centre of large cities. The adults are normally on the wing in June and July, but a second generation flies from August to September.

British plusiids Of the truly indigenous plusiid moths, one of the commonest and most widespread is the burnished brass, whose brilliant patches of metallic-golden green account for the moth's rather unusual name. On the wing from June to September, this species usually flies at night, although it can occasionally be found during the daytime. Except in the extreme north, it occurs almost everywhere in open country, especially lowland areas where its chief foodplant–stinging nettle–grows in abundance.

Another widely distributed and common species is the plain golden Y which has a

It has been noticed, incidentally, that large immigrations of silver Y moths and painted ladies (migrant butterflies) tend to coincide–obviously as a result of favourable weather conditions. In September and October southerly movements take place which appear to help the moths return to the Mediterranean.

Like other plusiids, the silver Y is on the wing after dark, when it visits a variety of night-opening flowers such as honeysuckle and jasmine. It is frequently attracted to artificial lights. Occasionally in the late summer you may see silver Y moths flying by day as well and busily feeding on buddleias and iceplants. Recent research has revealed that these are newly arrived migrants from the Continent, urgently replenishing themselves with nectar. Their migratory urge apparently overcomes their natural reluctance to fly by day.

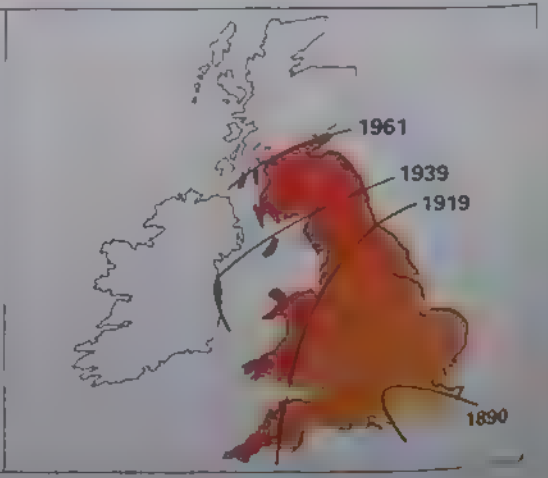
Rare ni moth Another migratory plusiid is the ni moth, similar in many ways to the silver Y but paler and smaller. It is a rare, though regular migrant to southern Britain, and has been known to breed in the south-west.

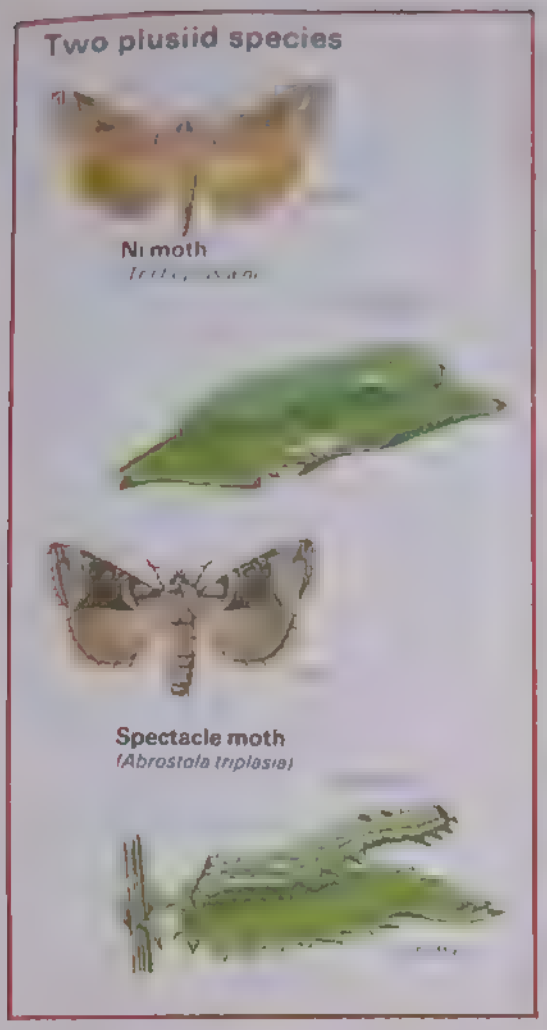
Since 1952 the ni moth has been recorded more frequently, particularly in the good years of 1953 and 1958. In 1982 more ni moths were seen than ever before and some individuals reached as far north as Yorkshire, and as far west as County Cork in Ireland (although they didn't penetrate Ireland any further).

Above: A golden plusia moth (*Polychrysia moneta*). Were it not for the popularity of larkspur and monkshood–the golden plusia caterpillar's foodplants–in English gardens this species might never have established itself so successfully here

Right: The beautiful golden Y (*Autographa pulchrina*) is not unlike the plain golden Y, although it has a more marbled appearance on its forewings

The spread of the golden plusia
In 1890 the first golden plusias were captured in south-east England. Since then this southern Continental species has spread rapidly through Britain. It is still extending its range northwards through Scotland, although less rapidly recently. In 1939 the moth established a foothold in Co. Dublin, but does not appear to have spread.





golden metallic mark on its purplish-brown forewings. Its white-dotted, yellowish-green caterpillars feed on a wide range of food-plants, including stinging nettles, dead nettles, honeysuckle and hawthorn. The adults are nocturnal fliers and are on the wing in June and July.

The beautiful golden Y–another plusiid–is not easy to distinguish from the plain golden Y, although it has a more marbled appearance on its forewings and golden-edged cross lines It flies as a single generation in June and July and is common all over the British Isles, although less so in the south than elsewhere.

Northern survivor A number of plusiids have a predominantly northern distribution–an unusual occurrence as most insects are more common in the south than the north. One such species is the gold spot, readily identified by the scattered metallic spots on its golden brown forewings. The gold spot is well adapted to an existence in marshlands and other waterside habitats, where its rather pale green caterpillars feed on yellow iris, bur-reed and various marsh grasses and sedges. Adult moths are on the wing in June and July, and sometimes again in August and September (a second generation).

Bespectacled species An interesting looking plusiid is the spectacle moth, its name deriving from the oval-shaped marks behind the moth's head, which–with a little imagination resemble spectacles When viewed head-on these curious marks may frighten away potential predators

It is found almost everywhere except Shetland, and has two generations a year. The adult moths fly at night from May to July and again in August and September, when they can be seen feeding eagerly at night-flowering plants. Spectacle moth caterpillars feed exclusively on stinging nettle leaves and are seen at night in July and September.

Above. The silver Y moth (*Autographa gamma*) is an extremely common species, despite the fact that it cannot survive our winters, and depends upon a fresh immigration each year

Below: A truly indigenous species is the burnished brass (*Diachrysia chrysitis*)

WINTER-FLOWERING WITCH HAZELS

During the long dark winter months many parks and gardens are cheered up by the presence of a witch hazel bearing clusters of brightly coloured flowers. A closer look shows that these flowers have curiously shaped, strap-like petals.

The witch hazels form a small group of five or six species comprising the genus *Hamamelis* in the family Hamamelidaceae. The exact origin of the name 'witch hazel' is somewhat uncertain, though the shrubs bear no relation to our own native hazel, which belongs to a quite different family. The latter part of the name probably comes from the similarity of the leaves in the two groups, while the former part may refer to the flexible nature of the twigs. The Old English words 'wich', 'witch' and 'wych' were often applied to plants with particularly pliant branches, a feature of interest to water diviners. It is thought that the early American colonists noted the similarity between the British hazel and witch hazel, which is native to that part of the world, and used twigs of the latter to try to locate water.

Above: The Chinese witch hazel flowers from December through to February. It was introduced to Britain in 1879 after being discovered growing in central China.

Right: The leaves of the cultivar *H. vernalis* 'Sandra' in autumn. Most witch hazels have lovely autumn colours, the leaves turning shades of yellow, orange or red. The name 'witch hazel' is due partly to the fact that the leaves are reminiscent of hazel

Some members of the genus are native to North America while others are to be found in eastern Asia – a distribution described by botanists as being disjoint. A similar pattern can be seen in the natural distributions of several other trees and shrubs cultivated in Britain as ornamentals. An example is the magnolias.

Flowers and fruits Witch hazels are easily recognised by their flowers, which are borne in clusters along the slender twigs. Each flower has four strap-like petals arising from the base and a cup-shaped calyx formed from the four sepals. Contained within the petals and calyx

Witch hazels

are four stamens and an ovary which is t[illegible] by a two-armed stigma Thi[illegible] varies only slightly betw[illegible]n th[illegible] different species of *Hamamelis*

Seed production in witch hazels is a slo[illegible] process since fertilisation does not [illegible]r until seven months after pollination. It usually takes another five months for the see[illegible] develop they are black and very shiny, borne two at a time in a capsule formed from the calyx. When ripe, the seeds are ejected, o[illegible] with some force, for which the plant [illegible] sometimes known as the snapping hazelnut

American species The most widespread of the American species is the common witch hazel (*H. virginiana*) which occurs in woodlands as understorey shrub from Georgia in the south as far north as Nova Scotia. It was the first witch hazel to be introduced to Britain–in 1736. It grows to a height of about 4m (13ft) and the small lemon-yellow flowers open in September while the leaves are still green and remain on the bush until November, during which time the leaves turn yellow and fall. A feature of this species is its olive-green calyx cup–in other species it tends to be brown or reddish.

Another American species is the Ozark witch hazel (*H. vernalis*) from the Ozark Mountains in central southern United States It was not introduced to Britain until as recently as 1910. Unlike the common witch hazel, it is a winter-flowering species, bearing orange to wine-coloured flowers during January and February. Individually, the flowers are tiny and scented. The Ozark witch hazel forms a wide-spreading bush and sometimes grows to a height of more than 9m (30ft).

Asian species The Asian members of the genus are generally more flamboyant than the American ones. The Chinese witch hazel (*H mollis*) is probably the most spectacular of them. It has broad flat petals, often more than 2cm (¾in) long, which vary in colour from pale lemon to deep golden yellow. The calyx, by contrast, is a deep maroon. The scent from the flowers can be overpowering.

The Japanese witch hazel (*H. japonica*) was introduced to Britain slightly earlier than the Chinese–around 1870. It is a quite distinct species with slender flowers bearing narrow twisted petals that make the tree look very delicate. It flowers at the same time as the Chinese witch hazel–December to February–and hybrids between the two are sometimes produced.

Horticultural value Witch hazels have long been popular among gardeners for the blossom they provide at a time of year when little else is in flower. One of their greatest virtues is extreme hardiness–they can often withstand temperatures below freezing by recoiling their petals and then unfurling them again when conditions become milder. Another remarkable feature is the longevity of the flowers–some last for as long as seven weeks.

Most witch hazels grown in gardens have been selected for their colour, scent or overall shape. These cultivars, with names such as 'Arnold Promise' and 'Lombard's Weeping', are perpetuated by grafting the selected specimen on to the rootstock of the common witch hazel, which tends to be more vigorous than other species.

Above: Flowers and foliage of some witch hazel species and cultivars–note how only the common witch hazel bears both at the same time Also shown is a typical flower structure

Left. The Chinese and Japanese witch hazels can cross to form the hybrid *H.* × *intermedia*, which in turn has given rise to many cultivars One of these, 'Ruby Glow', is shown here in its autumn colours. It is named primarily after the colour of its leaves, which are a bright coppery red

The leaves and bark of witch hazels have long been used as a source of a lotion for soothing bruises, minor cuts, insect bites and rheumatic pains

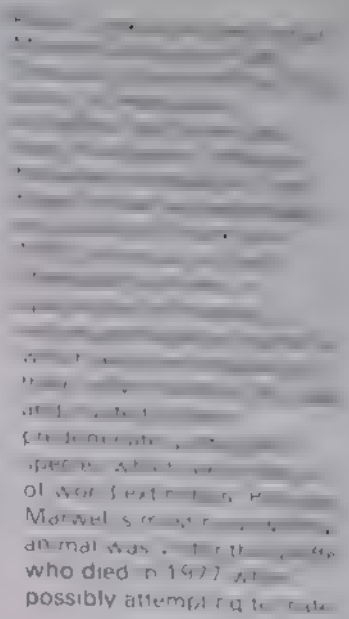
MARWELL: THE ZOO'S OTHER WILDLIFE

Although zoological parks are primarily maintained to care for exotic animals in captivity, their tranquil rural setting encourages an interesting variety of native wildlife. One such is Marwell Zoological Park in Hampshire where British and foreign species prosper together in an idyllic country setting

Many people think of zoos as places only good for the exotic inhabitants of the various cages and paddocks. However, in many of our better-run zoos, such as Marwell Zoological Park, especially those set deep in the countryside where there is no shortage of land and different habitats, there is opportunity for a wide variety of native flora and fauna to prosper as well.

Marwell consists of grass pastures on a predominantly chalky soil, with pockets of clay. Mature oak woods, hazel coppices, elms and horse chestnuts occupy several acres, while a yew tree walk, reputedly of Tudor origin, is still a feature of the zoo. At some stage in the estate's history several specimen exotic trees were planted, including redwood and a cedar of Lebanon. Limes, walnuts and copper beeches grow there as well. The paddocks for the animals are grazed by herbivores and occasionally cut; the grassland available for the public is mown, but the woodland is largely left alone except for some coppicing of hazel which is used as browse for some of the herbivores.

Zoo species The animals in the zoo are of various species to provide sufficient variety to attract visitors, however the two major groups of animals are big cats and hoofed animals. The zoo's collection of hoofed animals, particularly the antelopes and Mongolian wild horses (Przewalski's horses), is world famous. This horse is one of the most important species in the zoo -a unique horse from ancient evolutionary stock that only became extinct in the wild in the last 15 years



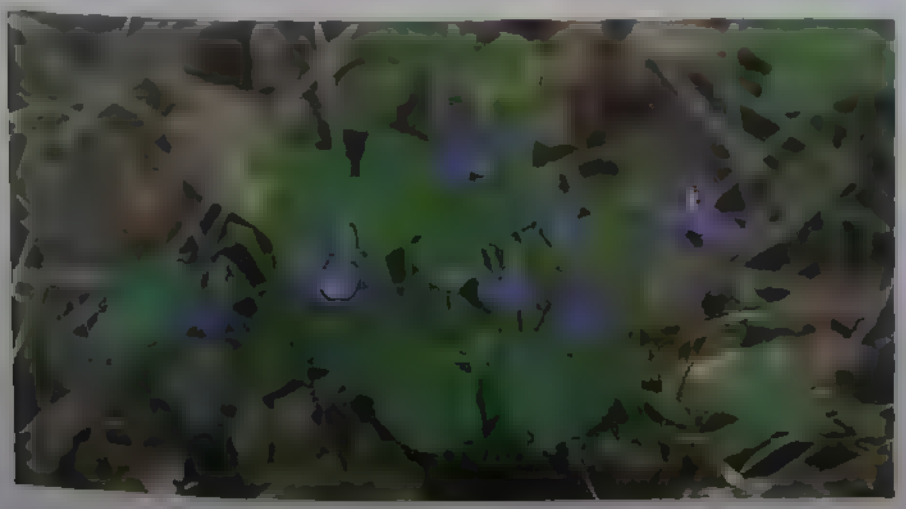
Below Foxes are rare and unwelcome visitors to the zoo. On one occasion a fox corpse was found in the Mongolian wild horse enclosure, apparently having been trampled to death by the horses

because it competed with man–and lost–for a limited water supply. It is genetically different from all other horses: its mane is erect and there is no forelock of hair. The tail is short and rather like a brush

The zoo's policy has been to establish large herds of deer, antelope, zebras and other ungulates so that their paddocks are many acres in extent with 40 or more animals grazing on them. Where practicable, mixed groups–for example, antelope, zebra and ostrich–are maintained. The big cats are kept in wire mesh enclosures on grass, with hazel and mature trees in the enclosed areas where appropriate. The enclosures are only roofed over when the cats are good climbers. Thus

Right. A rabbit on guard near its burrow. Although much of the grassland at Marwell is grazed by the various introduced resident species, rabbits in particular also keep the grass down. They in turn attract carnivores such as stoats and weasels

Below: The early dog violet is one of the first spring flowers found in the woodlands Marwell is particularly attractive at this time of year



[illegible] tigers and Asiatic lions are open-topped

[illegible] fed stock attract a wide [illegible] the zoo to feed on food [illegible] by captive animals, and the water in the [illegible]. The [illegible] other mamma

Wild birdlife Birds of prey are often present in the zoo and little owls are not an uncommon sight. Like tawny and barn owls, they have nested in the zoo. One pair nested above a pair of otters and fed their young on the dead chicks which were intended for the otters. For several years barn owls nested in a stable adjoining the curator's house, and members of the staff who have stayed at work in the evenings have become used to the ghostly shapes flying by. Both a buzzard and a merlin have been spotted: the merlin spent the morning in the children's zoo before flying off. Sparrowhawks are not infrequently seen, probably attracted by the large number of young birds to be found. Apart from captive birds, the zoo supports enormous numbers of starlings, crows, jackdaws, and of course sparrows. Birds often use exotic feathers and hair for their nests; wild boar and peccary hair and the soft feathers from flamingos and emus, for example

Various waterbirds are attracted to Mar-

Above: Fallow deer are rare visitors. There are no herds in the immediate vicinity of the zoo, yet small groups have been seen by the zoo fence on several occasions. Roe deer, on the other hand, are extremely common around the edge of the park.

Below: An orange-tip butterfly alights on a clump of primroses. There is abundant insect life at Marwell, particularly as there is no need for intensive chemical controls.

well. Zoo but the most regular visitor and perhaps the most dramatic is the heron which fishes for goldfish in the black swan pond. For several years it was at the pond almost every morning and evening, occasionally with another heron. It has been a less frequent visitor recently, though quite why it should fish less often is not clear.

Sadly, most of the visitors to the Park do not notice the wealth of birdlife around them, except perhaps for the moorhens. Every year upwards of five pairs nest in the zoo and moorhen chicks bring traffic to a halt as they are marched across the roads by the ponds. Canada geese make an occasional appearance; mallards breed in large numbers, mainly around the flamingo pond, and a pair of mute swans once landed in the black swan pond. This necessitated catching and releasing these birds as they could not gain enough height to clear the fence round the water. The general activity and the unexpected arrival of two strange birds greatly upset the pair of black swans, but they recovered and nested for the first time soon afterwards. Although those eggs were stolen, a later clutch was successful and two cygnets were raised.

To enable the flamingos to be left out at night without being threatened by foxes, an electric fence was installed around their pond. An interesting side effect of this has been that the greylag geese, which share the enclosure, began to rear chicks much more successfully after the introduction of the fence. These greylag geese are fully winged, spending their day flying round the zoo and neighbouring land. It is one of the great sights of the zoo to see the geese flying overhead, honking as they come into land, scattering flamingos and mallard as they go.

Mammal life Marwell zoo concentrates mainly on breeding mammals. Most of the staff are particularly interested in mammals and it is interesting to collect together some of their observations. The one aspect which is obvious to anyone who spends much time in and around the zoo is the presence of native deer. The park is surrounded by farmland and woodland and it is possible to see roe deer

around the perimeter fence almost daily. The population of these deer in this county Hampshire is very large and it is quite a common sight to look down into a herd of Axis deer from India at [illegible] just a few metres away on the other side of the fence. Fallow deer are much less common. More surprising is the [illegible] male red deer which stayed within a mile of the zoo for three days, and on another occasion an adult female was observed crossing the nearby country lane.

Other large native mammals seen around the zoo include badgers which used to have a sett within what is now the zoo. Close to the Yew Tree Walk an enclosure for red pandas was built into a bank at the base of some oak trees. This bank contained an old and long disused badger sett, but it was not until the excavations for the panda exhibit were made that the extent of this sett was revealed. It has been suggested that the badgers were driven out by the ghost of Ann Boleyn who reputedly wanders the length of the Yew Tree Walk and haunts Marwell Hall.

Grey squirrels are seen daily in the zoo attracted by the remains of picnics left in the litter bins, or dropped in the grass as is sadly the habit of many of the visitors. These squirrels border on pest proportions although they are not controlled for various reasons. Driving around the zoo at dusk seeing almost every litter bin disgorging squirrels is a pleasing sight in some ways, but the cost to the zoo is large. Rats and mice do have to be controlled, especially in a zoo with so much dry and pelleted food for the hoofed stock, primates and birds. Food stores are lined with steel and are rodent-proof, but they nevertheless manage to make a good living and would increase out of hand if allowed.

These rodents and the large rabbit population bring stoats and weasels into the zoo, although these are often only in evidence from the remains of their kill. However, a weasel has been seen attacking a young rabbit in the car park, while just 9m (30ft) away 40 people were getting off a coach. The population of voles and shrews is so far an unknown quantity; there are plans for some Longworth trapping in the near future. While mentioning native predators and their prey, the most destructive and dangerous predator to find its way uninvited into the zoo, the feral domestic cat, should not be excluded. Unfortunately there have been a few visiting the zoo over the last 11 years. They have killed several waterfowl and caused much damage.

Plants The plant life of the zoo is perhaps not as dramatic as the native animal life because much of the estate is grazed or mown. However, the spring flowers are a particular feature of Marwell, and while primroses, daffodils, violets and bluebells may be common enough in places, it is certainly unusual to find them in such abundance in a zoo. One orchid which usually thrives is the early purple, and the bee orchid has been recorded.

Up to 300,000 people visit the zoo each year and may take a close interest in the captive livestock. No attempt has been made to recreate the plains of Asia or the bush of Africa at the zoo–visitors spend their day in an English country park. One wonders how many realise that they are also walking through a sanctuary for native wildlife among a marvellous variety of flora and fauna.

Above: A great spotted woodpecker at its nest, and (below) jackdaws collecting quantities of nesting material in spring. Woodpeckers are popular visitors. In 1979 a great spotted, lesser spotted and green woodpecker all made their nests within the grounds of the zoo.

UNDERWATER EEL-GRASSES

Above. A bed of eel-grass at low tide The most common British species, *Zostera marina*, has a range extending from the low water mark of spring tides to a depth of about 4m (13ft). It cannot survive for long out of water–unlike the other two British species, which can both grow in the intertidal zone as far up as the halfway point

Below: Eel-grass is one of the main food plants of Brent geese overwintering in Britain. They suffered badly with the *Zostera* plague of the 1930s

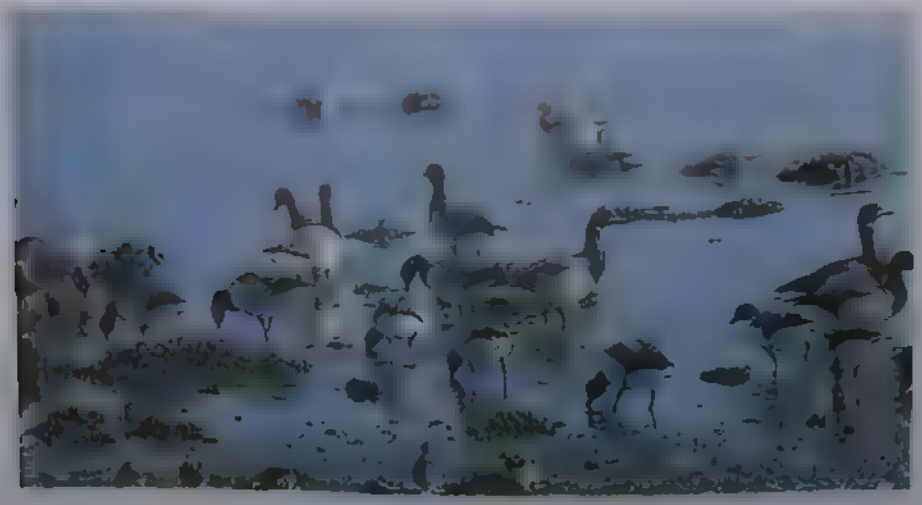
If a lettuce leaf is immersed in a solution of salt water similar in concentration to sea water the leaf gradually loses its shape and becomes flaccid. Clearly something that has the function of a skeleton has been removed from the leaf. This 'skeletal something' is water, which makes up the bulk of a plant cell. When placed in a salt solution this water flows out of the leaf and into the solution by a process known as osmosis, and the leaf loses its hydrostatic skeleton

The ability of salt to remove water from plant tissues is the reason why most plants avoid the very salty conditions of the seaside Those that do grow there have developed devices such as a thick cuticle (leaf covering), fleshy leaves and a cell sap with a high concentration of salts to prevent water loss from sea spray. Among these plants is one small group that has become fully marine and can survive beneath sea water. It is represented in Britain by the genus *Zostera*, commonly known as eel-grass

Looking like seaweed There are three British species of *Zostera*, of which *Z. marina* is the most common and can be taken as typical of the genus. It is perennial, rooting into fine gravel or sand around the sea-shore. It has dark green leaves which may be up to 1m (3ft) long yet only 5-10mm wide. The leaves are alternately arranged and flattened with sheaths at their bases. The whole plant looks far more like a seaweed than a flowering plant. The leaves have large spaces between the cells acting as buoyancy chambers to keep them afloat

Just as the whole plant looks quite unlike a typical flowering plant, so do its flowers. They occur on shorter fertile branches and are very much reduced. Male and female flowers are separate but borne on the same plant, and appear when the sea temperature reaches 15 C (59 F)–usually July in southern England. The flowers are in two rows, the males being reduced to a single anther and the females to a single ovary with two stigmas. Pollination is by water. The single anther produces two long filaments which are the pollen. Their density enables them to remain at the depth at which they were released for a considerable time, often several days. This gives the pollen filaments a better chance to encounter receptive stigmas.

The seed is enclosed in a green membranous wall which photosynthesises, building up a



small bubble of oxygen inside. Eventually ruptures the wall and releases the mat... These are heavier than w... persed by current... and perhaps also for short distances on the feet of bird... The char... seed germinating are l... are recorded in the wild. Most re... seems to be vegetative from short pieces of rhizome br...king off the parent plant ...d being carried away on currents.

Zostera marina is usually found grow...g in 1-4m (3-13ft) of water, often forming fairly large stands. Out of water, however, it is very susceptible, half an hour's exposure to warm air on a sunny day being enough to kill the base of the leaves; once that has happened the rest of the plant does not last long.

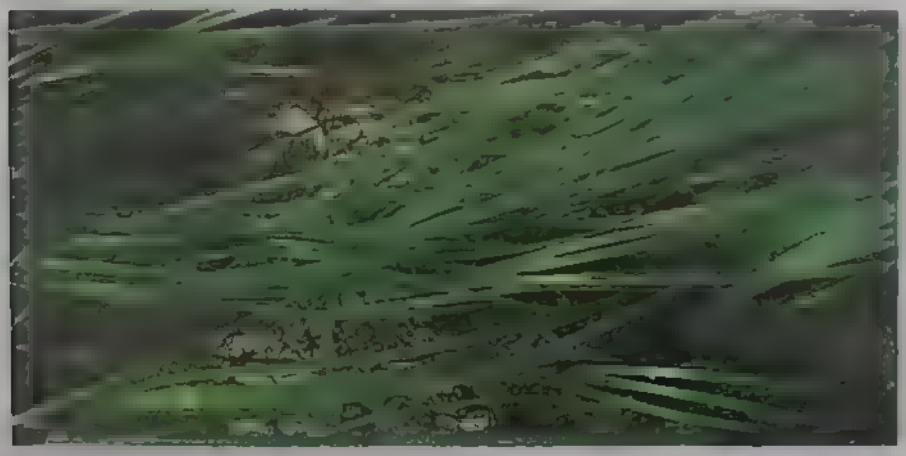
Rarer eel-grasses The second British species of eel-grass, *Zostera angustifolia*, is a much smaller plant than *Z. marina*, its longest leaves being about 25cm (10in) in length and only 2mm wide. The flowers are more or less identical to those of *Z. marina* and similarly reduced in size. There are no identifiable petals or sepals. Seed production and germination rates seem to be greater than those of *Z. marina*.

Z. angustifolia grows in a somewhat different habitat from its more common relative. It prefers mud flats in estuarine conditions, from

...also have the remains of a perianth.

Uses for man and birds The genus ... would appear to be nothing more than a botanical curiosity but *Zostera* is, however, important for several reasons. One is that it is harvested as a crop and used as a packing material for Venetian glass... and for heat and sound insulation.

More important perhaps, eel-grass – particularly the two smaller species – is one of the main foodplants of overwintering Brent geese, and a very large proportion of the world's popu...ation w...nters in Britain. During the 1930s a mysterious plague struck our beds of eel-grass and killed a great many plants. The effects on the Brent goose population was disastrous, but fortunately both the eel-grass and the Brent geese are now recovering their numbers.



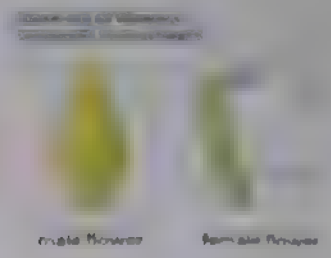
Above: The typically long narrow leaves of eel-grass, here seen at low tide rooted into gravel.

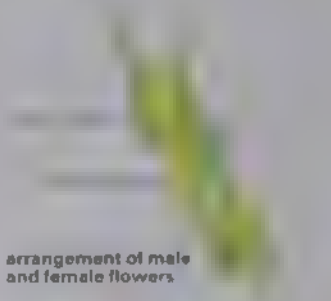
Britain's eel-grasses

Zostera marina The largest of our three native species. Its leaves grow to a length of 1m (3ft) and are 5-10mm (¼-½in) wide.

Zostera angustifolia Leaves grow to a length of 25cm (10in) and are only 2mm wide.

Zostera noltii The smallest of the three. Leaves grow to a length of 12cm (5in) and are less than 1mm wide.





arrangement of male and female flowers

RUFF: WADER WITH A DIFFERENCE

Most British sightings of the ruff are of the bird in winter plumage, but our few breeding ruffs give a chance to watch their unique spring display.

The ruff is a medium-sized wader: the male bird, at about 28cm (11in), is visibly larger than the female, which is about 22cm (8½in) in length. Outside the breeding season the plumage of both sexes is very similar, being mottled brown above and pale brown and white below. In flight two conspicuous white oval patches are revealed at the base of the tail, separated by a dark central band.

During the breeding season the male grows a remarkable set of plumes around the head and neck, which form the 'ruff' which gives the species its name, as well as long ear-tufts. Because of its long plumes the word ruff is also used to refer to the male bird, while the female is called the reeve.

Both the colouring and the pattern of the ruff's plumes are extremely variable. Three main types of colouring, and four types of pattern, have been described: there is little or no similarity between the colouring of the ruff and of the ear-tufts. About half the males have black ruffs, while their ear-tufts may be black, chestnut, pale buff, cream or white. The remaining males are fairly evenly divided between chestnut ruffs and pale to white ones, with corresponding variation in their ear-tufts.

Displaying at the lek In the breeding season the male ruff does not form a conventional pair with a female, as do so many birds, but instead the males gather at a communal display ground, called a 'lek'. There they posture with their plumes erected, and threaten

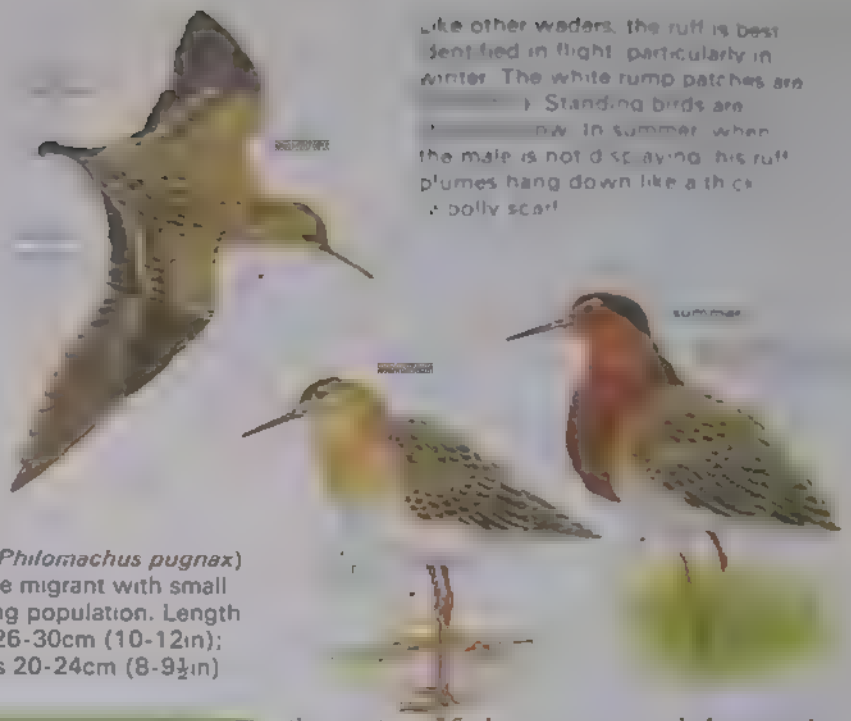
Above. This male ruff has a pale brown and black-barred neck-ruff and chestnut ear tufts. This colouring suggests that the bird is likely to have intermediate status, for the dark males are almost always dominant, while the light-coloured ones are usually subordinate.

Below. In winter the ruff is a mottled brown above, with light brown and white underparts, male and female being very similar. In Britain ruffs are seen more in winter than in summer.

and fight with rivals. The usual number of males at a lek is between 5 and 20, though up to 50 have been recorded. The lek is usually a raised grassy knoll or sometimes a bare muddy patch in marshland.

The site is highly traditional, in some cases records show that the same place has been used for at least 100 years. Once the males arrive on the lek, they go through a repertoire of displays. These include raising their ear-tufts and plumes, opening and flapping their wings to show off the white undersides, and rushing at neighbouring or interloping males. The male birds make short flights, and even indulge in actual fights in which rival males leap in the air and strike at one another aiming blows with their wings, beaks and feet. Fights such as this can last ten minutes or more, and may be repeated several times in a day.

The complicated performance at the lek eventually leads to the establishment of a hierarchy or 'pecking order' within the group



Like other waders, the ruff is best identified in flight, particularly in winter. The white rump patches are [illegible]. Standing birds are [illegible] now. In summer, when the male is not displaying, his ruff plumes hang down like a thick dolly scar[illegible]

Ruff (*Philomachus pugnax*) Passage migrant with small breeding population. Length males 26-30cm (10-12in); females 20-24cm (8-9½in)

Above: This traditional lekking site looks like a grassy lawn; in fact it is grazing land, which is fairly typical. Of the four males displaying here, one of the two dark ones is most likely to triumph

of males. Some become dominant, holding territories of a few square metres within the lek area, while others remain subordinate and fail to obtain a territory. Yet other birds fall in between the dominant and subordinate categories; they continue to attempt to obtain a territory, provoking continued fights with territory holders. Some of the subordinate birds which have given up trying to get a territory, or never even really attempted it, are tolerated even within a territory held by a successful dominant male, but any bird still seeking a territory is turned upon and ruthlessly driven away.

A further extraordinary feature of ruffs and their leks is that the dominance of a particular male is clearly linked with the colouring of his plumes. It has been found that males whose ruffs and ear-tufts are mainly dark in colour are much more likely to gain territories than those which are predominantly pale or white.

Watching females All this remarkable displaying and fighting has the ultimate aim of attracting a female or females to come to a particular male for mating. The females stand at the edges of the lek and seem attracted by the mixture of plumage type and the actual behaviour of the male: the more the male displays and fights the greater the attraction.

The most successful and dominant male on a lek may mate with over half the females present, but this is not to say that less dominant males, or even some subordinate males, never mate. On the contrary, some of the subordinate males, with no territorial ambitions, when tolerated on the territory of a dominant male, may in fact mate quite often.

Decline into rarity Two to three hundred years ago ruff were common breeders in Britain, but the species declined steadily, partly through land drainage and partly because the birds were caught for food. Breeding in Britain ceased altogether in 1922. Then in 1963 a few of them started to breed again, on the Ouse Washes on the Norfolk-Cambridgeshire border. Ruff have continued to breed there ever since, particularly now that most of the area is a bird reserve. Breeding has also taken place less regularly in the last 20 years at about another ten places in England, Wales and Scotland, though overall numbers of nesting females has never greatly exceeded 25 in any year.

Where to spend the winter Small numbers of ruff spend the winter in Britain, though whether our own breeding birds do so is not known. The majority of our wintering ruff must be from the main breeding range of the species, which extends eastwards from Scandinavia right across the northern parts of the Soviet Union. More birds winter round the Mediterranean, but the great majority go further south, to central and South Africa. Counts of about one million have been made in both Senegal and Nigeria, and perhaps even more than this round Lake Chad in central Africa. In winter the sexes are segregated: British wintering ruffs, for example, are mostly males, and females gather elsewhere.

Above: Most of the nesting reeves in Britain are on the Ouse Washes

WHIRLPOOL WILDLIFE

Although popularly associated with deep, sinister water swirling below a waterfall, whirlpools may occur in every river in Britain. As such they can be very varied indeed.

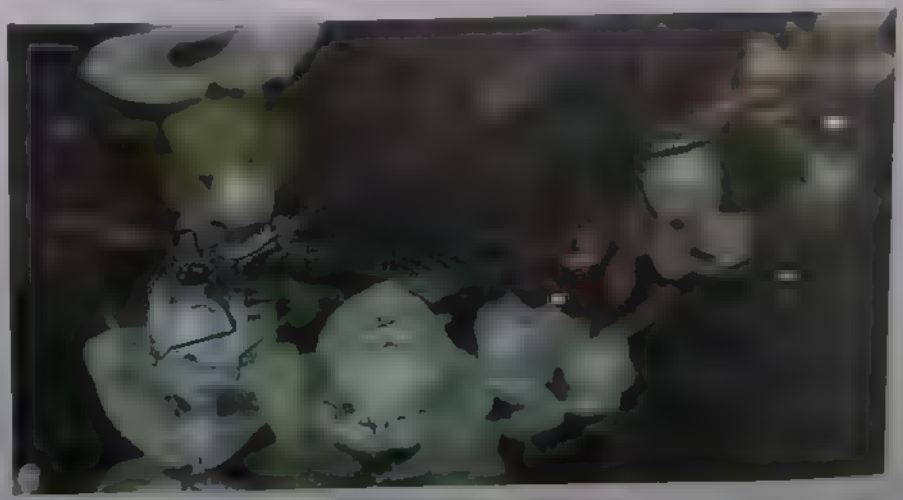
Whirlpools may result from a wide variety of natural processes; hard rock, soft rock and natural obstructions are all important in their creation. Man-made obstacles also contribute to their formation, many being the unwitting result of the building of dams and weirs. These and a host of other obstructions to the flow of a river create whirlpools.

To river wildlife, whirlpools are an invigorating extension of an already diverse habitat range. In the uplands they may be the only place where deep water occurs, and provided the pool is large enough it is likely to have many micro-habitats within it. Deposits of fine gravel are common among large boulders while abrasive water forces may act on some surfaces which themselves produce sheltered alcoves. In the lowlands whirlpools may be the exact opposite of their upland counterparts–the only section within a sluggish river in which visible movement is always evident Otherwise uniform stretches, which have just sand, silt or clay on the bottom, may fleetingly change to coarser gravels. The water itself may become freshened by the addition of oxygen as it tumbles over obstacles or flows in shallow riffles. In chalk streams, which are characteristically faster-flowing and with gravel substrates, the whirlpool represents the slower, deeper, siltier habitat of the system

Plants of upland whirlpools Plants in these areas are often highly adapted to a particular

Above. An example of a whirlpool created by sudden constriction along its banks

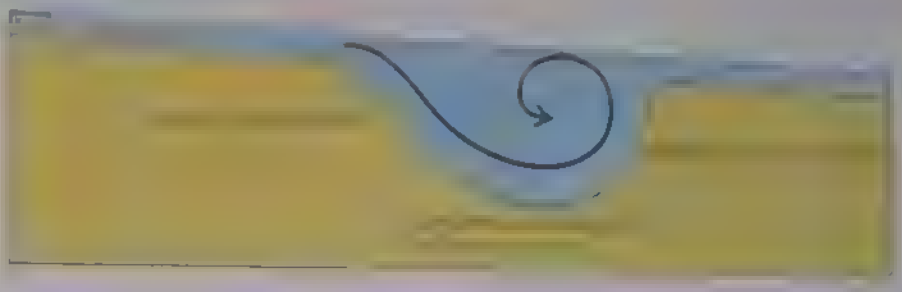
Below: *Agrion virgo*, one of several splendid damselflies associated with lowland whirlpools. Other typical species include *Agrion splendens* and the white-legged damselfly. Upland whirlpools support the large red damselfly (which can be a common sight as it flits gently between the emergent bank flora), and the large golden-ringed dragonfly



Whirlpools

In upland areas, where the slope of a river can often be steep and varied, whirlpools ranging from as small as 2m (about 6ft) to over 20m [illegible] type are principally formed by rivers descending rapidly in shallow, narrow and sharply inclined channels which suddenly reach deeper sections and are then abruptly brought up short by solid rock obstacles. This results in whirlpools which have great turbulence at their downstream end that produces dangerous undercurrents. Shown here is a cross-section of this form of whirlpool.

Upland whirlpool

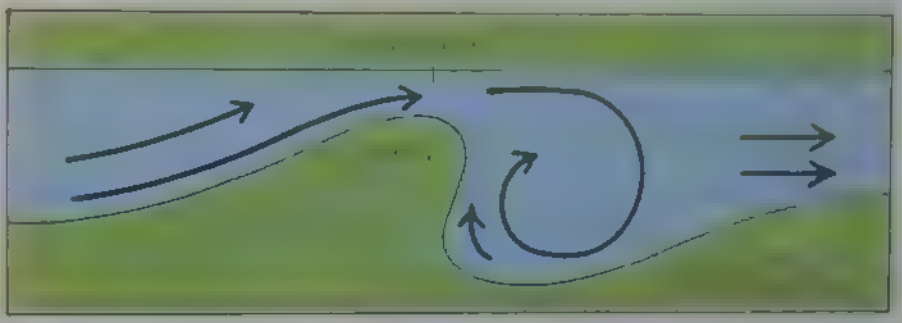


Waterfall whirlpool

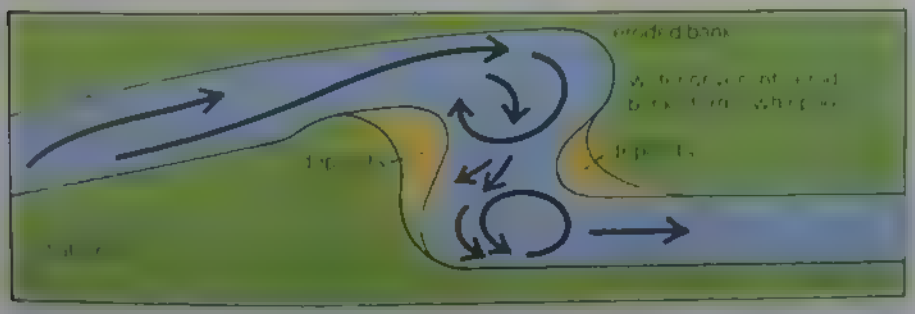
Invariably the downstream section of a waterfall will contain a whirlpool–this is obvious from the very nature of the lie of the land. The whirlpool may be formed by the sheer force of water coming down over the fall at high speed, which makes the water tumble back on itself, or it may be created because the course of the river is channelled to one side or the other, so that lateral swirling of the water occurs. In some cases the two processes may even occur in the same waterfall. Again, our diagram shows a cross-section of this type of whirlpool.

Where solid protuberances are found within a river channel which divert the water into a narrow channel, whirlpools are usually found immediately downstream of the obstruction. The increase in velocity at the downstream end of the obstacle frequently results in the formation of a pool by erosion and this in turn leads to a swirling whirlpool. Such pools may produce large 'mushrooming' currents at the point where the downstream flow of water is checked by the rise in the substrate level at the end of the pool. Shown here is the view from above the pool.

Obstruction whirlpool



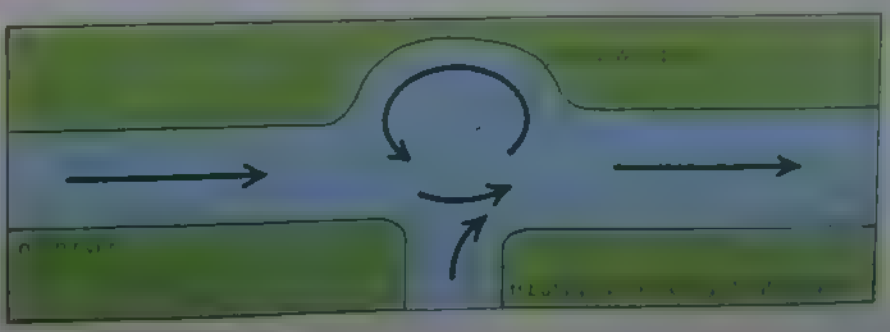
Erosion/deposition whirlpool



In lowland rivers, the most common type of whirlpool to be found is that caused by the meandering of the channel. This causes erosion on one bank, with corresponding deposition on the opposite bank. In meanders which are particularly sharp and which have therefore eroded a deep pool, the whirlpool is at its most spectacular, for the full force of the water is driven into a sheer, often crumbling soil profile which turns the water full circle. Note that the bank where erosion occurs is steep, while that where deposition occurs is flat. This view is from above.

Where the inflow of a tributary stream is a most the same size as its recipient or main river, a whirlpool is often created. This is particularly true on occasions where the tributary enters the river at a right angle. The whirlpools created here are frequently deep, with unstable, shifting substrates. This is because the discharges of water from the two rivers frequently do not rise and fall consistently; the loose material–gravel, silt and a variety of other debris–on the river bed is consequently pushed first one way and then the other. This view is from above.

Tributary interference whirlpool



Above: The sheer force of water tumbling over the rock in a waterfall gouges out a hollow at the bottom, in which the water swirls and 'boils' at a furious rate

Left: Purple loosestrife may often be seen flowering along the banks edging whirlpools

Below: The marginal rocks and gravels by upland whirlpools may be covered by cushions of mosses, such as the *Dicranella palustris* shown here

identified

In cracks between solid r[illegible] mosses and tough, [illegible] found, some being perfectly adapt[illegible] totally submerged. Others may be [illegible] tougher and able to tolerate both [illegible] water velocity and periodic de[illegible]. However, these are relatively less [illegible] whirlpools than they are in other upland river habitats because the whirlpool characteristically does not rise and fall in height so fiercely. Instead, the marginal rocks may be covered by moisture-loving thalloid liverworts such as *Pellia epiphylla*. On rocks in gently swirling water may be found a whole host of lower plants which are attached firmly by holdfasts. However, where the pool accumulates fine gravels it may be possible to find either the alternate-flowered water milfoil or the intermediate water-starwort.

Animals of upland whirlpools These, of course, depend on the variety of habitats and the plants which these support. Blackfly larvae are characteristic of rocks on the downstream edge of the pools. These areas may be fully exposed to the full force of water and the blackfly is one of a handful of species which can tolerate such conditions.

The sheltered stones and gravels within the whirlpools are a much richer habitat for invertebrates. In large rivers with pure peaty water the large pearl mussel may be found. The caddis fly *Hydropsyche* is also well-adapted to life among stones or the fronds of

milfoil. Scampering over and under ston[illegible] the flattened larvae of mayflie[illegible] and stoneflies (*Perlodes*) are typical. In small whirlpools in peaty uplands the feathery three-tailed larvae of the large red dam[illegible] or the ferocious-looking golden-ringed dragonfly may be found.

Lowland whirlpool plants These plants differ greatly from their upland counterparts and show marked variation according to the water velocity and nature of the river bed. Where the water is shallow and the substrate is composed of gravels, water crowfoots are usually the dominant plants. On the raceways, weirs sluices and dams which create whirlpools, two algae are very common: they are the tough and leathery blanket-weed *Cladophora* and the soft pelt-like *Vaucheria*. Both thrive where nutrient-rich water flows rapidly.

Well-vegetated whirlpools are associated with clay rivers in which the substrate is rich but firm enough for plants to anchor. In the deeper parts can be found the yellow water-lily, a robust and resourceful plant. Various species of pondweed may also be seen swirling in the currents.

On the undercutting vertical earth banks which face the whirlpool may be found many colourful annual flowers. If the bank is stable and not eroding, then trees and shrubs often occur and these frequently have exposed root systems which provide habitats for animals.

Animals of lowland whirlpools Among the gravels where the substrate is coarse and the oxygen level is high many mayflies and stoneflies, which are absent from the rest of the river, may be common. Stonefly larvae have a preference for moving water which makes whirlpools an important habitat for them.

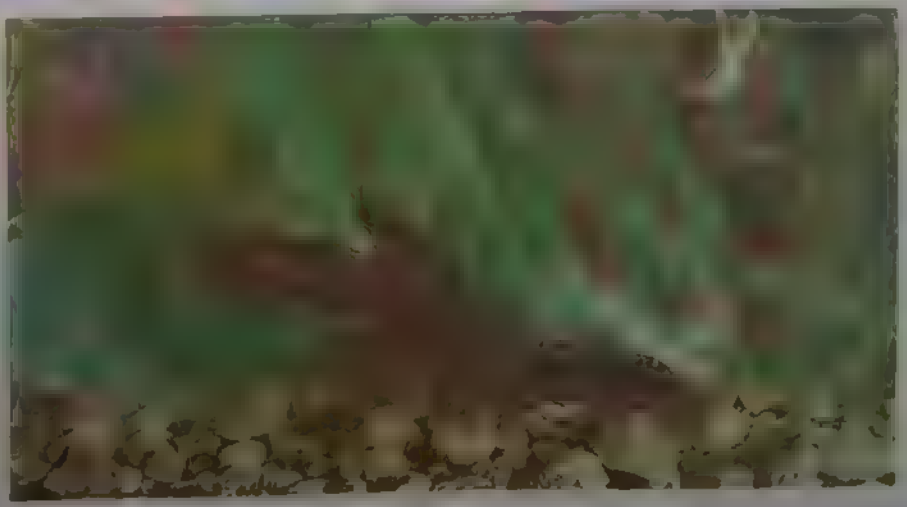
The steep banks facing whirlpools may be important as nest sites for such waterside birds as sand martins and kingfishers, the former preferring to nest in soft, open, crumbling banks while the latter like some cover. On flat and reedy margins may be found a wide variety of bird nests, varying from the large mounds built by swans to the precariously balanced nests of coot and moorhen.

The gravels of lowland whirlpools are important for maintaining populations of some fishes. Both the river and brook lampreys occur throughout Britain except in north-west Scotland. However, without well-oxygenated sands and gravels to spawn in they would be absent from lowland Britain too. Whirlpools frequently provide just such suitable habitats–habitats which are also exploited by native populations of brown trout, stone loach and miller's thumb. Many coarse fish are also associated with whirlpools, which must be deep and well-vegetated. Here the swirling plants provide cover for the invertebrates on which the fish feed, as well as a habitat in which some lay their eggs. Typical species include the pike, tench, rudd, roach and chub.

Above: Whirlpools created by meanders in the river, with erosion one side, deposition on the other.

Right: Amphibious bistort is one of a community of flowering plants that may form on the shallow muddy edges of whirlpools. Other such species include reed sweet-grass and great yellow cress. Purely emergent stands usually contain bur-reed, interspersed with yellow flag, flowering rush and purple loosestrife.

Below: Whirlpools remain the only habitat in some lowland rivers in which the crayfish still occurs. This species requires well-oxygenated, calcareous water and may be found among the fine underwater rootlets of marginal alders and willows.



MUSSELS: FOOD FOR THE TAKING

The edible mussel is a bivalve mollusc, related to oysters and clams. This important commercial species is abundant along Europe's Atlantic shores: it often grows in estuaries, being well adapted to withstand strong currents as well as the action of waves.

The common or edible mussel (*Mytilus edulis*) has the ability to attach itself to almost any hard object in the sea by means of its byssus threads, a bundle of fine but tough brown fibres, which are also called the 'beard'. These adhesive threads are secreted by glands at the base of the foot, and once a mussel is firmly anchored to a rock, pier pile or even another

Above: A bed of edible mussels exposed at low tide. They seal themselves shut to avoid drying out.

Right: Submerged mussels open their shells to take in water through their frilly gill filaments

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The edible mussel

days a free-swimming larva emerges. The larva slowly develops a shell as it drifts in the surface layers of the sea for one to four months, depending on water temperature. During this period it is carried about by the tide and by sea currents, so that it may travel hundreds of miles from the parent stock. While in this planktonic phase it passes through several stages of development before actively seeking the sea bottom where it metamorphoses into a bottom-living stage known as a 'spat'. The microscopically small spat undergoes various stages of development, some of which are mobile and some of which settle temporarily on a seaweed or a hydroid colony. Finally the spat settles permanently on suitable ground, to metamorphose into a very small mussel. Spat often settle in massive numbers near the low water mark of spring tides.

Young mussels grow rapidly during their first summer, often forming dense banks or beds of mussels. These banks gradually rise as a result of a build-up of 'mussel mud', which is a sticky mixture of silt and waste material pumped out by the mussels. Sometimes these banks reach an unstable height and they may be lowered or washed away by strong tides, storms or currents. Mussel beds can also be destroyed by predatory animals such as crabs and starfishes, which invade and feed on the dense mussel clumps. Seabirds such as oystercatchers and gulls, as well as eider ducks, delight in eating succulent mussels, and they have various ways of extracting the meat from the shell.

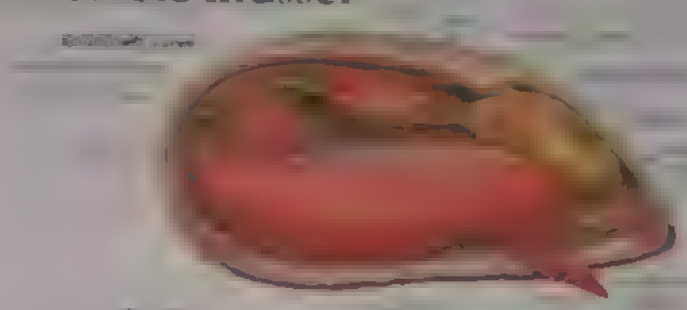
The young mussels are known as seed. They grow particularly fast if they have settled below the water mark around the mouths of estuaries or in other sheltered inshore sites, where the sea water is rich in phytoplankton. Conversely, the poorest growth is found high up on wave-beaten rocks or in the higher reaches of estuaries, where salinity is often greatly reduced by fresh water from upstream. In British waters the edible mussel grows to a final length of 6.5-8cm (2½-3¼in).

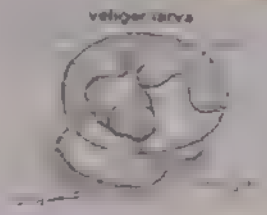
Mussels as a food The potential of the mussel as a source of protein has long been recognised throughout the world. In several European countries mussels are harvested in large quantities and served in a variety of ways. Annual mussel production in north-west Europe alone is about 300,000 tonnes, with a first sale value equivalent to about £30 million. The bulk of this catch is cultivated rather than gathered from natural beds.

British mussel production is relatively small, at about 5000 tonnes per annum, and comprises less than 2% of the total EEC production. Most of the mussels harvested in this country are sold on the home market, and are supplemented by varying levels of imports.

For centuries the natural stocks of mussels around Britain have been utilised both as a source of food and as bait for long-line fishing. Large areas of tidal flats, including the Wash, Morecambe Bay, Solway Firth and various other river estuaries, such as those of the Conwy in North Wales and the Teign and Taw in Devon, produce most of our mussel harvest.

These are all areas of natural production.

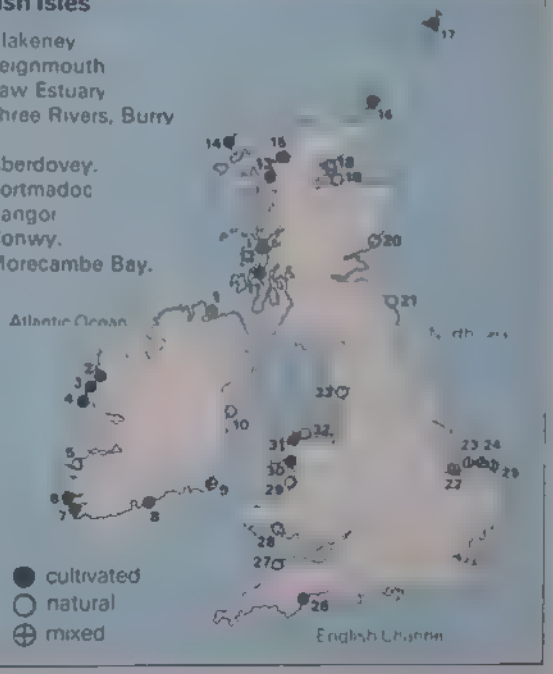




diagrammatic form rather than the somewhat compressed appearance of the ... would look if cut open. The ... floating larva ... shown on the left

Mussel fisheries of the British Isles

1 Lough Swilly
2 Clew Bay
3 Killary.
4 South Connemara
5 Cromane.
6 Kenmare
7 Bantry.
8 Youghal
9 Wexford.
10 Mornington
11 Sween.
12 Spelve.
13 Torridon
14 Western Isles
15 Glencoul
16 Orkney
17 Shetland
18 Dornoch Firth
19 Findhorn
20 Montrose Basin
21 Holy Isle
22 The Wash
23 Brancaster
24 Wells-next-the-Sea
25 Blakeney
26 Teignmouth
27 Taw Estuary
28 Three Rivers, Burry Inlet
29 Aberdovey.
30 Portmadoc
31 Bangor
32 Conwy.
33 Morecambe Bay.



Below: The byssus threads, by which mussels attach themselves to any hard surface, are seen in this picture. These tough brown threads are secreted by glands below the foot

The commercial development of natural bed however abundant they might seem, is hindered by the unpredictable nature of their growth This makes the investment that would be necessary extremely risky It is impossible to predict the rate of recruitment of new mussels to the beds, for this depends on the frequency, abundance and precise location of the settlement of spat. These factors in turn are variable because they are controlled by complex ecological factors

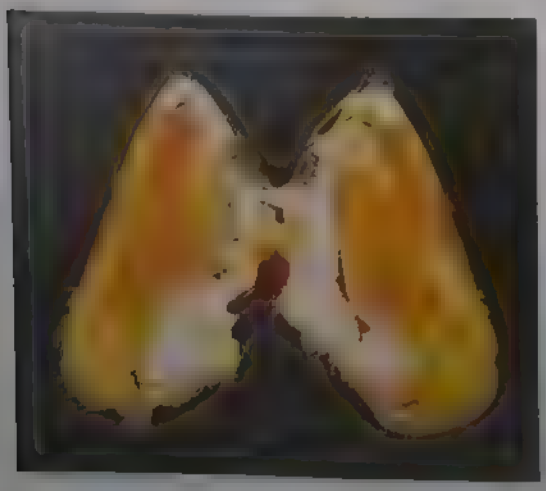
Another problem with natural beds is that crabs and other predators take a heavy toll of the seed and the growing mussels. A third problem, though a relatively modern one, is the increase in coastal sewage pollution. This has affected the natural beds rather than the cultures because the natural beds tend to occur in estuaries, and these are most commonly used in sewage disposal schemes, particularly those set up in the 1920s and 1930s. Being filter feeders, the mussels simply pump in any faecal bacteria present in the sea water, thus becoming polluted

Because of various illnesses which can result from eating mussels contaminated in this way, fresh sales are nowadays prohibited under Public Health regulations unless the mussels have first been purified in an approved purification plant.

Farming mussels In order to avoid the uncertainties of natural production, mussels are being farmed in several European countries. Various methods are used, depending on the geography of the coast and the velocity and height of local tides. In the right conditions, mussels grow faster, yield better meats and can be reared at a much faster production rate than in the wild. Mussel farming in Europe is now a large and profitable industry. The three principal farming methods are the raft or floating culture of Spain, the bottom culture of the Netherlands and the pole system used in France.

Bottom culture is also being introduced in Britain and Ireland. Small mussels (seed) are transplanted from natural beds, where growth or survival is poor, on to 'lays' or selected plots of sea-bed which are sheltered and have rich supplies of plankton. The process is usually mechanised; large dredging vessels collect tonnes of seed from natural beds, and place it on the selected lays. After a growing period of 20-24 months the seed mussels mature to market size; they are dredged up from the plots, sorted and washed ready for market

Above: A mussel dredger in operation harvesting bottom cultured mussels. The large metal dredger blade, with its net attached for gathering the catch, is lowered over the side while two fishermen give the boarded mussels a preliminary wash with the hose



Left. An edible mussel which has been cut open with a knife The blade has severed the animal into two halves, so that the body contents can be seen. The round white masses at the bottom of each side are the severed parts of the posterior adductor muscle. The white hinge joining the valves towards the top is the anterior adductor muscle. The fringed gills can be seen at the bottom of each side. The dark brown feature (looking like a tongue) at the centre is the foot. The yellow, folded tissue is the mantle, which in life contains the internal organs and secretes the outer shell

Floating culture Shellfish growers in some parts of Britain are now also using various methods of floating culture to rear mussels The mussels are grown on ropes suspended from rafts or buoys, or in net tubes. Areas with deep and sheltered waters are required for this type of culture operation, and the various sea lochs along Scotland's west coast, and around the Outer Hebrides and the Shetlands, have been found ideal. Trials in the past few years have demonstrated that in these areas floating mussel culture has good commercial potential, for it produces excellent quality mussels quickly.

Nutritious meat Today the demand for mussel meat is growing; as well as being tender, delicious and easy to digest, mussels are extremely nutritious. Mussel meat has about the same amount of protein as beefsteak, much less fat, only a quarter of the calories, and many more mineral nutrients. Many shellfish growers in Britain and Europe now consider the common mussel as potentially the most important mollusc in their waters, and efforts are being made to raise production and promote new sales outlets.

[illegible] A fu ly grown you[illegible] on a crag [illegible]

Bottom Ravens lay 4 6 eggs which take 18-19 days to hatch Fledging takes 5 weeks

RAVEN AND CHOUGH:TWO CLIFF BIRDS

The raven and chough differ from the other, more commonly seen birds of the crow family, for they belong to the wild places of the north and west.

The raven is a large bird, biggest of the whole crow family, measuring some 64cm (25in) in length and having a wing span as large as a herring gull's. Its legs, feet and bill are jet black. Size difference alone is a sure way to distinguish ravens from other members of the crow family if they are seen together, but when size comparison cannot be made it is not immediately easy to distinguish between the raven and the carrion crow. The most useful features then are the massive proportions of head and bill in the raven and, in flight, the gradually tapered tail as compared to the square-ended tail of the crow. Also helpful is the fact that ravens are vocal birds, calling frequently. Their deep, resonant croak is an almost legendary characteristic, which instantly draws attention and distinguishes the species from all others

Powers of flight Ravens are notable acrobatic performers on the wing. At any time of year, but especially in late winter and early spring as the breeding season approaches, ravens, which pair for life, often indulge in exciting display flights. The two ravens fly side by side, often at a great height, and one of them–most often the larger male–suddenly rolls upside down and continues gliding in this position for a short distance before righting itself again. Similarly, one of the pair may suddenly close wings and nose-dive through the sky with impressive power

Carrion feeder The raven is predominantly a carrion eater, taking advantage of the ready supplies of meat afforded by this food source. Ravens often assemble in large numbers where a surfeit of carrion is available. In Wales, where it is a common bird, the presence of up to a hundred together is not infrequent at refuse dumps or when severe weather has caused local kills of sheep. There have also been reports of up to 800 congregating at the carcases of whales in the Shetland Islands.

Not relying on carrion alone, ravens otherwise take small mammals, eggs of other birds if the opportunity arises and frogs, reptiles or any other available form of meat. Sheep farmers in the hills view the raven with some suspicion, and accuse it of attacking the eyes of ewes in labour and of killing new-born lambs and sickly sheep. Such fears do from year to year result in illegal persecution of the species (which is fully protected by law) although in the areas where ravens occur the numbers are generally fairly large and they weather such local persecution reasonably well.

International range The raven is an immensely successful bird throughout the northern hemisphere, absent only from the lowlands

of Europe and the eastern United States. It is a denizen of the frozen north, and equally an opportunist of the desert areas of the southern United States, the Sahara, Arabia and of the whole of central and eastern Asia and of most places in between. It is one of the world's most successful bird species, profiting as vultures do–from the inevitability of death in the animal kingdom and further benefiting from surplus waste produced by man.

Devon, Cornwall, Wales and the western and northern islands of Scotland are the

Above: A raven nest–possibly a few years old, but still in use–in a tree. Nests are built in traditional sites, and are enlarged a little each year. Ravens are a strictly resident species in Britain, and are among the earliest breeders in the year. Nest building is well under way in many areas by the end of February, and adults incubate solidly through the very worst of late winter weather

Left: The chough has suffered from the reduction in the area of short-grazed turf and windswept coastal heathlands, which contain an ample supply of its invertebrate food

strongholds of ravens in Britain, and in these areas their numbers are large. In Wales, nest sites are often at regular spacings of 4km (2½ miles) or so, but there is a considerable non-breeding population to add to this. The total number in Britain may well be in excess of 5000 pairs, and their general unfamiliarity is really the result of the remoteness of the regions they inhabit, rather than scarcity.

Captivating choughs How different from the raven is the chough: apart from being black, belonging to the same family and often sharing the same wild cliffs, the two have little else in common. Of all members of the family, the chough is the most popular, most captivating and indeed the only one which at no time can be said to conflict with man or his interests in any degree.

The chough is a lightly built bird, smaller than the crow or rook, and possibly more likely to be confused with the jackdaw, with which it readily consorts as these two species

Below A chough family at the approach of fledging Chough nest sites tend to be strongly traditional, like those of the raven Unlike ravens however, choughs nest deep in rock fissures in cliffs, in the roofs of sea caverns or, as here, in roof spaces of rarely visited buildings In these places they are safe from almost all forms of predation except for determined egg collectors The stick nest is well constructed on a ledge or in a cleft of rock and deeply lined with wool

often share the same [illegible] and nest sites Choughs can, however, readily be distinguished, both in flight and on the ground Their outline, and especially the widely fingered flight feathers, give them a unique silhouette on the wing, and on the ground the bright red legs and bill the latter being slender, long and decurved - are striking features which instantly distinguished the chough. Added to this is the fact that the chough, like the raven, is a vocal bird with a highly distinctive call - 'tchay, tchay' – which immediately draws attention to it above the cacophony of jackdaws, breaking seas and seabird calls

In flight, the chough is light and buoyant, a master of the close encounter, dashing and careering wildly about the sea cliffs with breathtaking agility and abandon. It loves to wheel, dive and rise with closed wings, turn on its back as ravens do, or perform steep upward arcs, calling continually.

Small prey Compared to the raven, the chough's feeding habits are wholly refined, as it is a highly specialised and selective feeder. In fact it is probable that the bird's very particular feeding requirements have been responsible for its widespread decline and [illegible] demise in the face of the agricultural change which has transformed rabbit-grazed turf to arable land and pasture

Choughs are invertebrate feeders, digging in soft turf with the long, curved bill and probing among rock crevices and the base of grass tufts for beetle larvae, moth caterpillars and other similar invertebrates They also feed successfully on sandy beaches along the strandline, or in pastures by chiselling open cowpats

Distribution of choughs The modern distribution of the chough in Britain is well defined It is predominantly a bird of the western coastal cliffs with strongholds in Ireland (about 680 pairs) and Wales (about 140 pairs) The Isle of Man has a stable population of 50 to 60 pairs, and in Scotland it is restricted to about 60 pairs on the island of Islay, with a few other small populations on nearby coasts Since 1968 it has been absent from Cornwall, one of the traditional homes of the so-called Cornish chough. In other areas, for example north Wales, it has actually expanded its numbers a little and taken advantage of inland quarries and sheep-grazed hillsides

In former days, when the land was less intensively cultivated and short turf was plentiful, the chough was a far more numerous and widespread bird, occurring round much of the coastline of England. It also bred inland across northern England

Raven (*Corvus corax*) Resident in coastal areas of the north and west, and in craggy mountains. Length 64cm (25in)

Chough (*Pyrrhocorax pyrrhocorax*). Resident in remote coastal areas of Ireland and west Britain. Length 39cm (15½in)

Round-up of the crow family

HYBRIDS: NATURE'S MONGRELS

Most plants in the wild are distinct species but some are the result of different species interbreeding to form often strange-looking hybrids.

Though plant hybrids have always occurred in the wild it has only been in the last few centuries that man has begun to 'cross' different plants to produce artificial hybrids One of the earliest records of a known artificial hybrid is that created by the nurseryman, T. Fairchild, who in 1717 crossed a carnation with a sweet William. Today, however, the production of plant hybrids is big business in both horticulture and agriculture, and our understanding of the subject has led to the discovery of natural hybridisation in many different plant groups

What is a hybrid? The definition of a hybrid revolves around the concept of a species The modern theory of evolution and ideas on breeding behaviour have led scientists to consider the species as the standard biological unit. In classification systems, groups of closely related species are put into the same genus and groups of related genera are arranged into families. Hybrids occur when the boundaries between these discrete breeding units are crossed. Hybridisation may occur between two different varieties of plants within the same species, or between different species in the same genus, or even between species in different genera.

Hybrids between varieties A pure-bred line of a particular species, selected for certain qualities such as colour, shape or size, is called a variety. If two different varieties of the same species are crossed with each other, the result is called an intervarietal hybrid. In the last few years many intervarietal hybrids have featured among our favourite foods and flowers. The list includes vegetables such as early, middle and maincrop potatoes, and a wide range of cabbages, tomatoes and so on. Among flowers, new nursery catalogues are filled each year with artificial hybrid monsters such as pelargoniums, petunias, pansies, roses and sweet Williams.

Hybrids between species If a hybrid is derived from two different species, it is known as an interspecific hybrid. Such hybrids are common among both flowering plants and ferns, whether in the wild or in cultivation. Notable examples occur in the orchid genera *Dactylorhiza*, *Orchis* and

Above: A hybrid between primrose and cowslip. Note how the general shape of the plant, with its long-stalked flower-head, is similar to that of a cowslip though the flowers themselves are reminiscent of primrose flowers

Left. 'Stardust'—one of many hybrid pelargoniums developed for the gardener.

Right: Water avens (left) and wood avens (right) flanking a hybrid between the two.

Above: Crosses between species in different genera are rare in the wild. The small white orchid (*Leucorchis albida*) shown above, however, may cross with the fragrant orchid (*Gymnadenia conopsea*) below to form the intergeneric hybrid on the right

Ophrys, the willowherbs (*Epilobium*), the mints (*Mentha*), the willows (*Salix*) and violets (*Viola*), but perhaps the best-known and most studied interspecific hybrids are those in the *Primula* genus

There are three native species of this genus in the British Isles–the primrose, the cowslip and the oxlip. Hybrids occur between all three species. The one between oxlip and primrose is found in two localities in East Anglia; the oxlip × cowslip hybrid is also very rare but can be found in a few well-established wet meadows in west Suffolk, west Norfolk and Cambridgeshire.

Undoubtedly the most common hybrid in the group, however, is the one between the

ch is widespread in
st of Wales, in eastern
arts of Ireland. It usually
individuals rather than
lations and, although the
fertile, they tend to
ation plants. These are known as first filial generation, or F_1, hybrids because both parents are pure species. Sometimes an F_1 hybrid crosses with a parent or with another hybrid to produce F_2 or later generations. A mixture of such hybrids is known as a hybrid swarm.

In the case of primrose × cowslip hybrids the offspring plants are intermediate between the parents, in terms of leaves, flowers and degree of hairiness. Hybrids usually have a stalked inflorescence similar to that of a cowslip, though a few individuals have their flowers borne on stalks rising directly from the base, in the manner of a primrose.

Intergeneric hybrids Hybrids between plants in different genera are less common in the wild than interspecific hybrids, though a substantial number have been artificially created. The large majority of intergeneric hybrids are between very closely related genera, and in all cases between genera in the same family. In the British flora, well authenticated natural intergeneric hybrids are known only in five families: the spleenwort family (Aspleniaceae), which are ferns; the daisy family (Compositae); the grass family (Gramineae); the orchid family (Orchidaceae); and the rose family (Rosaceae).

Among the flowering plants the best studied intergeneric hybrids are those involving the spotted orchids in the genus *Dactylorhiza* and the fragrant orchids in the genus *Gymnadenia*. It seems that whenever species from the two genera occur together they readily form hybrids. For example, two subspecies of the common spotted orchid (*D. fuchsii* subsp. *fuchsii* and subsp. *hebridensis*) form hybrids with the fragrant orchid (*G. conopsea*) in many parts of the British Isles, mostly in the south though also in the Hebrides. Invariably some of the characters of the hybrids are intermediate between those of the parents. In most plants the short rounded basal leaves so typical of the common spotted orchid are absent, though the leaf spots found in that parent are usually present. In most hybrids the lip of the flower has the same lobed shape as found on the common spotted, though some have the equal-length, truncated lobes of the fragrant orchid. The most notable contributions of the fragrant orchid are the long slender spur on the flower and its sweet scent.

Hybrids in the wild Species are normally prevented from hybridising in the wild by various kinds of isolating mechanisms or breeding barriers, the breakdown of which allows crossing to take place. The plants may grow in different parts of the country or in different habitats; they may have different and specific pollinator preferences or flower at

Above: One of the 'freaks' of the plant world—the chimaera known as *Laburnocytisus adami*, a graft hybrid between the common laburnum (*Laburnum anagyroides*) and purple broom (*Cytisus purpureus*) Because it was produced by grafting rather than cross-fertilisation, its features (particularly the flowers) are clearly derived from either one parent or the other, rather than being intermediate between the two. This chimaera arose accidentally in France in 1825 and no one has since been able to resynthesise it—all plants now known are derived from the original one

Right: A vigorous hybrid between the common spotted orchid (*Dactylorhiza fuchsii*) and the southern marsh orchid (*D. praetermissa*). Surrounding it are the much smaller southern marsh orchids and also a few early marsh orchids

[illegible] is found [illegible] sedges. They also flower [illegible] times—wood avens from [illegible] water avens from April to [illegible] September in good years. But because they are genetically very similar to each other whenever they meet they form hybrids [illegible]

A frequent cause of hybridisation between species in different habitats is the boundaries between them becoming blurred or distorted. Many hybrids occur in farmed cultivated or forest-felled areas where man's activities produce new kinds of habitats in which hybrids can grow.

Graft hybrids All the hybrids mentioned so far have resulted from cross fertilisation. But it is also possible to make graft hybrids called chimaeras—by grafting a small cutting called the scion of one plant on to the rootstock of another. Usually the branches produced by such a hybrid can be attributed to one parent species or the other. Sometimes, however, buds arise from the graft union and the shoots from these buds therefore contain cells from both parents. The result is a plant in which some parts can be seen to derive from one parent and some from the other parent

HOW INSECTS EAT

Insects are a diverse group–and this is reflected in their diets, for together they have exploited nearly every feeding opportunity that exists.

Above: The adults and larvae of the common wasp have completely different diets. While the adults feed on nectar, the juices exuding from rotting fruits, and the honeydew produced by aphids, the larvae are carnivorous, relying on small invertebrates supplied to them by the worker wasps.

Below: Cabbage aphids are equipped with sucking mouthparts so they can extract nutrients out of a plant's phloem

With over a million known species, and at least another million awaiting discovery and description, insects are easily the largest group of living organisms in the world. They are also the most diverse group, and this is particularly apparent from their mode of feeding and their diet

Chewers and suckers Two broad feeding categories can be recognised among insects the chewers and the suckers. The former–the chewers–have jaws which can bite and rasp at food. They include the plant-feeding species which leave holes providing clear evidence of their presence, and predators, which kill and rapidly dispose of their prey with bites. Examples of such chewers are grasshoppers–attackers of vegetation–and dragonflies which hunt and kill.

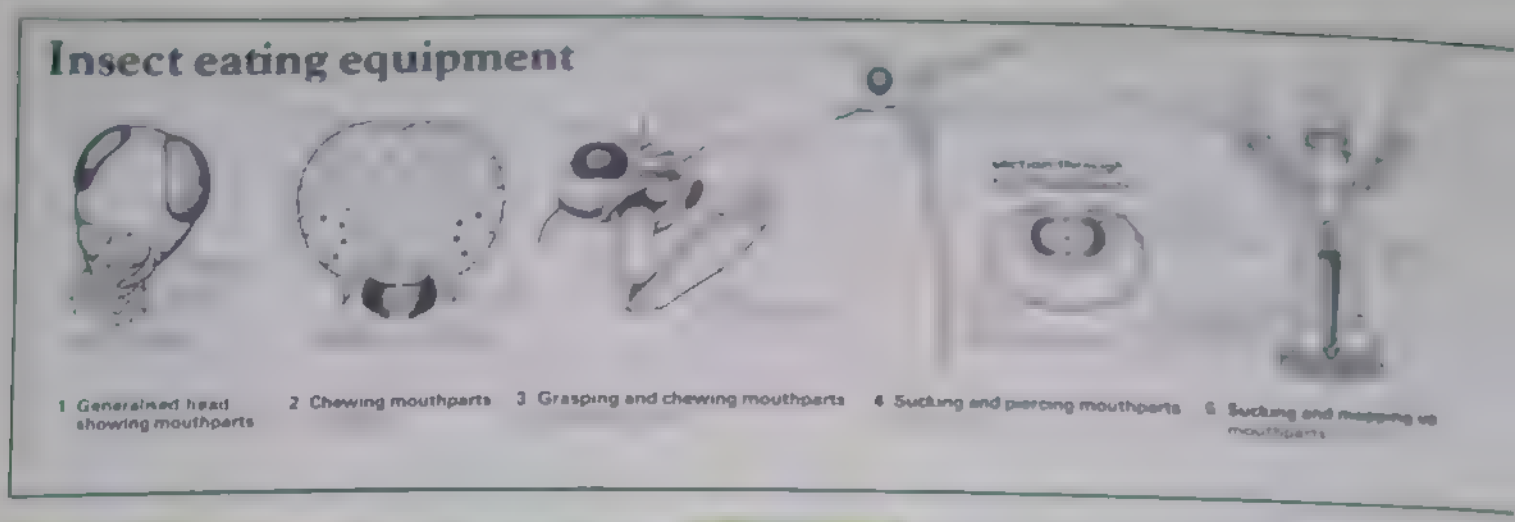
The second category, the suckers, have a tubular stylet or proboscis which they use to extract liquid food from living plants, animals, dung or rotting flesh. These insects insert their mouthparts either by pushing between crevices or by piercing and sucking out sap, juices or body fluids. Such a feeding method leaves little trace, and is seen in aphids (plant-suckers), and mosquitoes (blood-suckers).

Life-cycles and diets Insects can be further divided into two categories according to their life-cycles, which in turn also reflect their method of obtaining food. The insects with an incomplete metamorphosis, in which the immature stages resemble small adults and the transition between youth and maturity is gradual, tend to feed in the same way and have similar diets throughout their lives. Aphid nymphs and aphid adults, for instance, are both suckers, extracting nutrients from plants.

Those insects with a complete metamorphosis, in which the transition is less gradual, however, have larvae which feed, almost immobile pupae which do not feed, and adults which may or may not take in food–and if they do their diet is nearly always totally different from that of the larvae. Both beetles, which are mostly chewers, and butterflies, which are mainly suckers, fall into this category.

Sucking and chewing, then, are the two principal ways of obtaining food, and immature insects may or may not utilise the same resources and feed in the same way as adults.

Frothy froghopper One sucker with an incomplete life-cycle is the froghopper, also known as the meadow spittlebug. The nymphs of this species cause the small blobs of foam, often called cuckoo spit, which are found on vegetation in May and June. Soon after hatching from the egg (which overwinters among vegetation) the froghopper nymph pushes its stylet into new plant tissue until it locates the xylem–the water-conducting vessels in plants. It then extracts from the plant large quantities of water which pass through its alimentary system, before being pumped



Above: The emperor dragonfly, in common with all other dragonflies, is a hunter and a killer. Equipped with jaws that can bite and rasp at solids, it rapidly overcomes its victims by outflying them and then delivering a few fatal bites. You are most likely to see the emperor dragonfly in the sunshine or around nightfall hunting for smaller dragonflies and insects around ponds and lakes from June until early September. It is our largest hawker dragonfly.

into foam just as it leaves the anus. The nymph lives immersed in this foam which probably protects it from predators.

The plant's xylem contains small amounts of nitrogenous nutrients in solution, and it is these that constitute food for the developing froghopper nymph. As the nymph grows, so the foam blob becomes larger, until the nymph eventually moults and emerges as an adult. It then leaves the foam, which quickly dries up. Adult froghoppers feed less often than the nymphs and do not remain on the same plant.

Sugar-tapper The cabbage aphid is also equipped with a sucking stylet which it pushes into the plant's phloem, where the energy and nutrient supply is located. The resources of the phloem are altogether richer than the xylem so aphids are able to extract large amounts of sugar. This sugar solution passes through the aphid's body and is excreted as sugary honeydew, the stickiness of which is noticeable on the leaves of trees in dry summers.

Cabbage aphids are restricted to cabbages and related plants, so when there is a heavy infestation they are a considerable drain on the energy and nutrient reserves of a plant. They remain on the same plant, continually tapping the nutrient flow, and move away only when the supply dries up.

A moth's diet The elephant hawk-moth is an insect with a complete metamorphosis; the larvae feed in a totally different way from the adults. When fully grown, the caterpillars of the elephant hawk-moth are 9cm (3½in) long and decidedly chubby. By day they rest motionless at the base of rosebay willowherb stems and related plants, but at night they climb the plants and consume enormous quantities of leaves, defecating almost equally large amounts of frass (caterpillar droppings) at the same time. Elephant hawk-moth caterpillars must consume this vast amount as the food is neither particularly nutritious nor digestible.

In winter the nutrients and energy acquired by the caterpillar during the previous summer are used to power the metabolic processes that turn the large, fat caterpillar into a streamlined pink and black moth. The adult flies at dusk, and feeds by unwinding its coiled-up proboscis and inserting it into strongly scented, tubular flowers from which it sucks up sugary nectar. It does this while hovering in front of the flower; as soon as all the nectar is extracted it moves on to the next flower.

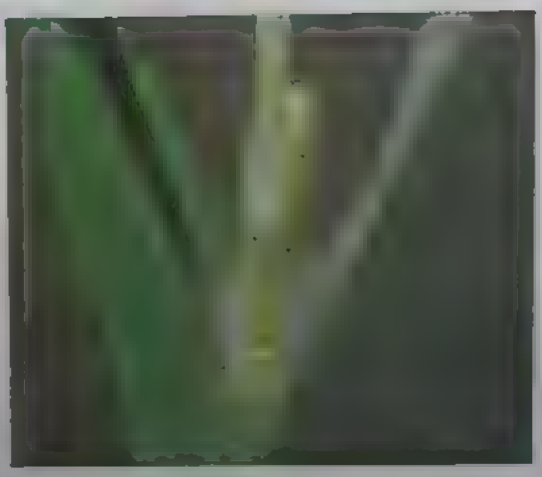
Nectar-feeder and predator Adults of the common wasp feed on nectar and other liquid food, such as the juices which exude from rotting fruit or the honeydew produced by aphids. Unlike the elephant hawk-moth, however, they also have to obtain food for their larvae which develop in the nest.

Once a wasp colony is well-established it contains thousands of cells, each with a

A typical insect s mouth (1) is surrounded by 3 pairs of appendages the mandibles for biting, and two accessory jaws–the maxillae and the labium Caterpillars (2) have wel developed mandibles while dragonfly nymphs (3) have enlarged labia for seizing prey. Plant bugs (4) have modified mouthparts for piercing and sucking, and houseflies (5) have fleshy mouthparts

Right: The elephant hawk moth is another species whose adult and caterpillar feed in different ways. While the chubby caterpillar (below) feeds on vast quantities of leaves, the adult delicately sucks in nectar through its long proboscis which it inserts in tubular flowers

Right: The foam you see on plants in May and June is produced by froghopper nymphs. Soon after hatching from its egg the nymph pierces the plant tissue and extracts large quantities of water from the plant's xylem (water-conducting vessels). The liquid then passes through the nymph's digestive system and out through its anus in a bubbly foam-like substance. The nymph then lives in this foam, which probably protects it from predators.



voracious larva which must be fed by the workers. The workers are fierce predators and scavengers, and attack and kill caterpillars flies, butterflies and spiders

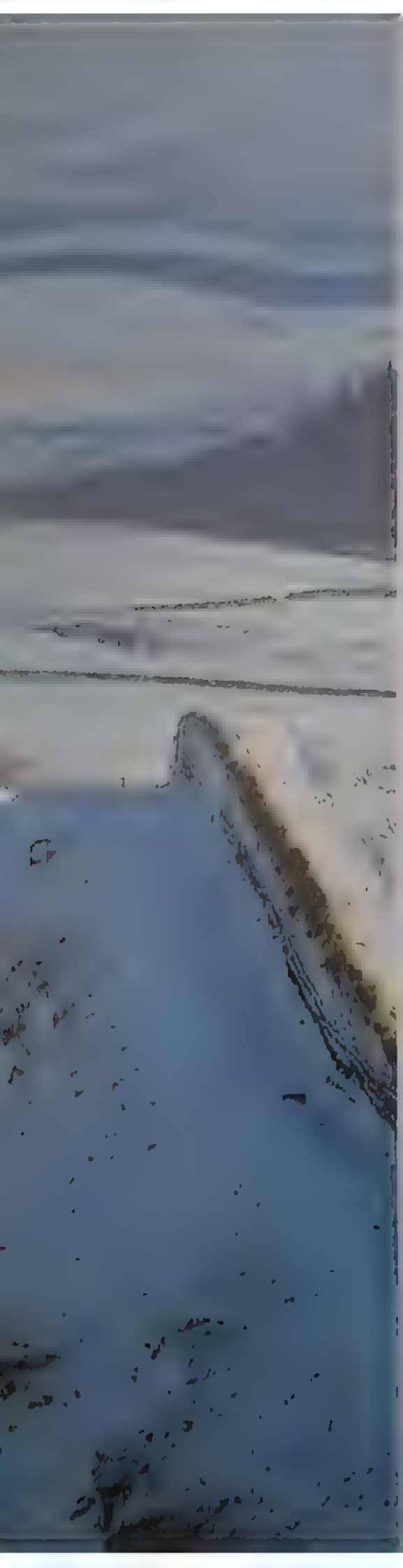
Cannibalistic ladybirds The seven-spot ladybird is a more typical predator than the common wasp. In spring the females lay little clusters of bright yellow eggs near, or among, aphid colonies. Upon hatching the tiny ladybird larvae rush for the nearest aphids and start devouring them. Provided there are planty of aphids to consume, the larvae grow quickly and soon form orange and black pupae attached to leaves and stems. If the aphids become scarce, the larvae attack each other–an example of true cannibalism. On becoming adult the ladybirds continue to feed on aphids, although if the local food supply fails they embark on long distance flights in search of better pickings

Parasitic fly maggots The bluebottle look-alike, *Protocalliphora sordida*, is an unpleasant looking fly, the adults of which feed on flower nectar although their maggots are parasitic. Female flies lay their eggs in the lining of birds' nests during the incubation period of the eggs. Here the fly maggots hatch, usually at the same time as the nestlings, and periodically attach themselves by means of a sucking disc to the bellies of the young birds. The maggots pierce with their mouth hooks and suck the blood, growing rapidly, but spend most of the time hidden among nest material. As many as one hundred maggots may exist in a single nest.

Froghopper, aphid, moth, wasp, ladybird and parasitic bluebottle are just examples of the varied ways in which insects find and utilise food–they illustrate the remarkable diversity that exists within the insect class.

NORTHUMBERLAND NATIONAL PARK

Northumberland National Park is a kaleidoscope of dramatically changing scenery–from the round grassy hills of the Cheviots, the high boggy moors of the North Tyne area and the vast Wark Forest to the north-facing crags carrying Hadrian's Wall

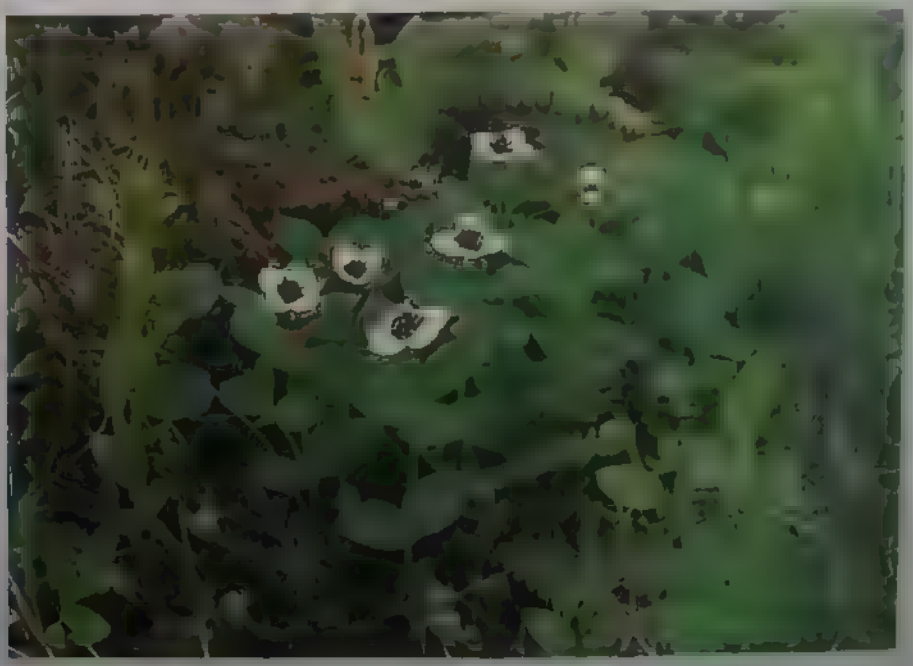


Left: Hadrian's Wall, shown here in snow just west of Housesteads is of course the National Park's most famous monument
The Pennine Way traverses the full length of the Park starting at Greenhead in the south-west, partly following Hadrian's Roman Wall, then continuing north through Wark Forest, across the high moors on to the Cheviot Hills and ending at Kirk Yetholm in Scotland, just outside the northern boundary of the Park. This walk must be the perfect way to see the Park and most of its natural history. The Northumberland County Council provide six information centres, sited at the main access points, and run a caravan and camp site in conjunction with the Caravan Club on the River Breamish in the Cheviot foothills

Below: Dwarf cornel grows high up on Cheviot Hill

One of the few parts of England to remain completely unspoilt, the Northumberland National Park was designated in 1956. Stretching from the Scottish Border on the north side of the Cheviot Hills southwards to the Roman Wall, a distance of 64km (40 miles) and covering an area of 1030 sq km (398 sq miles), most of the Park is upland over 300m (1000ft) high. It is an almost completely wild area with very few human settlements but with a good network of roads and almost open access for the walker. One area owned by the Ministry of Defence between the Rivers Rede and Coquet is used as a training area and is closed when in use. Another large area owned by the Forestry Commission provides many trails, car parks, caravan and camp sites and picnic areas, as well as complete freedom for walkers throughout their forests. Although the Northumberland County Council do own some of the park, the majority of the land is still privately owned and farmed with normal access over rights of way.

Geology and vegetation The Cheviot Hills were probably built up as a result of volcanic activity in the Old Red Sandstone Period about 300 million years ago, with later deposits of sedimentary strata laid down



Spout [illegible] can be seen in every burn in the Cheviot area. The Great Whin Sill runs right across the southern boundary of the Park at exposed north slope forming a craggy ridge that carries the Roman Wall along its crest.

There is a very wide range of habitat within the Park, supporting a diverse flora. As the area is mostly an upland one, upland grassland, heather moor and peat bog vegetation is well represented. In the past most of the upland area was afforested, carrying Scots pine, hazel, alder, elm, oak, rowan, ash and scrub birch, most of which was cleared by man during the spread of his early settlements. Any regeneration was prevented by cattle grazing. Only scraps of this original woodland have survived today, mainly on steep slopes where clearing is difficult.

The Cheviots Most of the tops of the higher hills are covered with a deposit of peat, with heather being the dominant plant on the drier parts and cotton sedges, deer sedge and

bilberry on the wetter parts, but in rocky ravines on the Cheviot Hill itself, where an altitude of 600m (2000ft) is reached, mountain plants occur. These include alpine scurvy-grass, chickweed willow-herb, alpine willow-herb, hairy stonecrop, mossy saxifrage, starry saxifrage, dwarf cornel, bog whortleberry, alpine clubmoss and roseroot. Moving down the steeper slopes on to the upland grassland where the soil is well drained, there are bent grasses and sheep's fescue, with smaller amounts of red fescue, moor mat-grass and wavy hair grass. Associated with this grassland are harebell, heath bedstraw, bitter vetch, field woodrush, tormentil and five species of bryophytes.

Within the steep Cheviot valleys the outcrops of andesite provide an interesting habitat for a wide variety of plants. This rock weathers into a rich brown soil with a high organic content and supports wild angelica, woodruff, foxglove, marsh thistle, bluebell, wood crane's-bill, cow parsnip, greater wood-rush, dog's mercury, burnet saxifrage, golden rod, wood sage, greater stitchwort, valerian, the oat grasses, lady fern, male fern and the hard shield fern. In wetter areas grow the sedges *Carex demissa*, *C. hostina*, and *C panica*, marsh hawk's-beard, water avens and meadowsweet. Among the choicer plants found here are hairy rock-cress, maiden pink, the maidenhair spleenwort and the brittle bladder fern.

In the lower valleys there are areas of meadowland which are quite marshy, being fed continuously by drainage from higher ground. Here you can find marsh marigold, flea sedge, melancholy thistle, wood horsetail, globe flower, marsh valerian, spotted orchid, purple orchid and the beautiful grass of Parnassus. Another community of plants occurs on the gravel beds of the streams, where you may still find shepherd's cress, parsley piert, carline thistle, cudweed, purple

Above. One of the Park's unusual mammals is the wild goat, which grazes in small herds on the Cheviot Hills

Top right: A distant view of the Cheviot Hills, which rise to more than 800m (2500ft) above sea level

Bottom right: The Cheviots have their own breed of sheep which graze the grass of the more fertile hillside soils. Two Cheviot lambs are shown here

Opposite left: The shy woodcock lives in the dense coniferous forests–this is a juvenile bird

Below: The red squirrel is found in areas where there are reliable cone crops, particularly of Scots pine

willow, annual knapweed and monkey [illegible]

Coquetdale and North Tynedale Moving southwards where the Carboniferous grits, limestones and cement stones replace the granite and lavas of the Cheviots, the predominant fell sandstone forms the Simonside Hills and the sandy acid soils support vast expanses of heather moorland. Where this moorland is managed by burning off to provide a supply of young heather for the sheep and grouse, very little else is present but mosses and lichens. In undisturbed areas grow such plants as chickweed wintergreen, petty whin and stag's horn moss

In this area there are numerous north-facing sandstone cliffs, exposed during the last Ice Age and all bearing the markings of glacial movement. It is here on the wetter ledges that you can find the lesser twayblade growing among the sphagnum moss. The woodland here is mainly birch with a few patches of juniper and upland oak; it supports a rich flora, especially on the more fertile soils where you can find dog's mercury, frog orchid, enchanter's nightshade, wood sage, lesser skullcap, bearded couch-grass, early wood anemone, pale sedge and cow wheat.

Moving west to Redesdale and the North Tyne region, large areas of blanket bog and grassland have been drained and planted with conifers. A good example of this blanket bog can be seen at Coom Rigg Moss, now a National Nature Reserve. This area has been

Above: A map of the Park. Most of Northumberland's rivers and streams have their sources within the Park Indeed, four of the main rivers radiate from the Cheviot itself and, as this area is mainly very poorly drained peat and soil, it holds back the rainfall like a sponge, releasing the water gradually into the rivers.

Left: In the more fertile hillside soils of the Cheviots you can find the lovely mountain pansy.

Right: In one section around Alwinton grows the rare Jacob's ladder, usually only found in limestone regions.

Upland loughs In the Park, which ... Whin Sill carry ... deep tr... tween the hard ridges of the ... the Northumbrian Lough... providing an interesti... You can see the succe... raised bog through the stages of reeds and fen At Crag Lough you can find pondweeds and shoreweed, and in the reed fringes are white sedge, cotton sedge, mare's tail, bog bean, reed grass, marsh cinquefoil, marsh speedwell and various mosses The dolerite rock weathers down well to provide an easily leached soil where cowberry and rosebay willowherb are common on the craggy slopes and heather and bilberry have helped to stabilise the scree slopes

Northumberland's birds Most of the park is upland with streams and valleys, providing a diversity of habitats for a wide selection of birds. The hills and moors are dominated by the curlew during the breeding season–this bird has become the emblem of Northumberland National Park. The higher hills are the haunt of the golden plover, buzzard, raven and occasional breeding dunlin, with red

grouse and ring ouzel on the hill slopes. The open moors are the home of the blackcock, short-eared owl and merlin, which nest in the deep heather

It is, however, the river valleys that carry most species of birds, with heron, dipper, oystercatcher, ringed plover, common sandpiper, pied, grey and yellow wagtails, mallard and goosander using the streams as highways. Feeding and nesting in the trees lining the stream banks are the green woodpecker, pied and spotted flycatchers, redstart, chiffchaff, willow warbler, tree pipit, wood warbler and blue, great, willow, coal and long-tailed tits. The wheatear nests in the drystone walls or scree slopes and the yellowhammer and whinchat in the gorse.

Many mammals Rabbits and hares are the most common mammals to be seen by the visitor, the brown hare being as numerous as the rabbit in the rough upland pastures. Badger and fox breed on the high moors as well as in the valleys and the fox is often seen on the hill slopes where there is less cover. The most elusive of the larger mammals is the otter, which uses the streams as highways, the spraints found on the dried river beds being evidence that it is still present in the Park

Although there are no wild red deer within the Park, roe deer are everywhere and their numbers have increased dramatically in the last two decades, occupying the large stands of new coniferous forests. Fortunately the red squirrel does not have to compete here with the grey squirrel, which does not breed in Northumberland. The field vole is abundant, providing a food source for the predatory birds, and its relative the water vole is common along the river banks. Stoat and weasel are present, and during the last few years escaped mink have increased in some areas

Above. A view upstream of the River Rede in Redesdale Forest

During the period of May to September guided walks are led by experts from various centres in the Park Full details are obtainable from Guided Walks Officer, Northumberland National Park & Countryside Dept, Eastburn, South Park, Hexham, Northumberland (tel Hexham 605555). A number of small nature reserves are owned by the Northumberland Naturalists' Trust and are not open to the general public. Details of these sites and membership of the NT can be obtained from the Hancock Museum, Barras Bridge, Newcastle

THE LUMPSUCKER: A TENACIOUS FISH

Ugly it may be, but with its gaudy colours and devotion to parental duty, the lumpsucker is one of the most interesting fishes of our inshore waters

Although not a commercial fish in this country, abroad it is valued for its roe, or 'lumpfish caviar'

Above: A young male lumpsucker in the typical shallow water habitat with a rocky sea-bed. On its back you can see the first dorsal fin, looking rather like a spike. As the fish reaches full maturity, the fin is reduced to a mere crest of low protuberances

Right: A close-up of the head of a male lumpsucker guarding its eggs. Just above and to the rear of the eye you can just see two small brown creatures clinging to the skin. These are external skin parasites and belong to the crustacean group called copepods. The two tail-like features on each parasite are egg sacs

[illegible] the more bizarre
[illegible] coasts of Britain [illegible]

[illegible] Lumpsucker
[illegible] reasons it has a
[illegible] its belly, forme[illegible]
thick, fleshy lips, its [illegible]
rows of coarsely spined plates. It guards
eggs tenaciously, the male is vividly
and overall, it has an unmistakably bulbou
appearance that leaves one in no doubt as t
how it obtained its descriptive name

Fish of stony ground Widespread along [illegible] northern coasts, the lumpsucker is less com mon in the south. For most of the year both sexes inhabit stony ground or mid-water in deeper offshore waters. In late winter or early spring, they begin to arrive in shallow rocky areas. The female is considerably larger than the male, and not uncommonly reaches a length of 60cm (24in). The males are usually 30cm (12in) or less. Both sexes are normally a drab grey, with white underparts

Breeding time In spring or early summer the lumpsuckers move inshore to the kelp zone By the time they arrive the male has assumed his breeding coloration, which gives him a most striking appearance. His sides become pink, red, yellow or even a combination of all three. The female, who does not change colour at all, selects a site for her eggs This can hardly be called a nest, for it is just a conveniently shaped depression in a rock surface into which she lays several thousand pink, sticky eggs

The male then takes charge of the site, and after fertilising the eggs he clamps himself firmly to the rock with his sucker, positioning his head against the eggs or, at the most, a few inches away. The female then plays no further part in their care, and very few females are seen until the following year

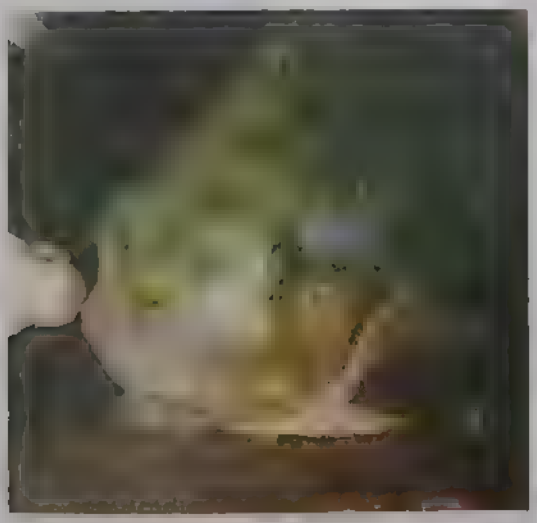
It is generally accepted that the male aerates the eggs by fanning with his fins or by blowing sea water with his mouth. He also devotes considerable efforts to guarding the eggs, and his bright colours and bulky appearance must be a deterrent to certain predators. The posture adopted on the rocks assists in blocking access to the eggs and the fishes frequently refuse to move, even when confronted and touched by a diver. If subject to major disturbance, they may swim a short distance away, but quickly return to assume their usual position once danger is past.

Over a period of weeks, the eggs gradually turn yellow and then grey. After hatching the young superficially resemble tadpoles, and

spend the summer mainly in the kelp Their colour, which varies according to the background, and their dull, scaleless skin provide ideal camouflage, so that they are very difficult indeed to detect, as they adhere to the kelp fronds. With the onset of cooler weather the young, like the adults, move into deeper waters

Dangers faced by lumpsuckers It is not thought that lumpsuckers are subject to heavy predation by any particular species. Because the nests are in some cases situated at low water mark, the males suffer attacks from gulls and other birds during spring tides. The greatest danger, however, comes from heavy swell conditions which are fairly prevalent at this time of year. There are probably considerable losses as a result. On the coast of Northumberland, it is not unusual to find dead lumpsuckers and even lumpsucker skins cast up on the shore. Though there is some mystery surrounding these dead fishes, the theory has been advanced that they are the victims of rough seas. This could be so, but local fishermen believe that the lumpsucker skins are the work of the grey seal

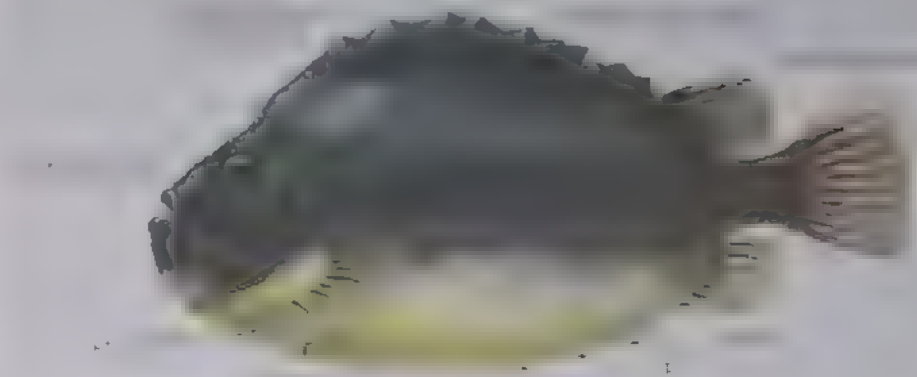
The lumpsucker is a poor swimmer and could not easily escape a seal; it is, however,



capable of short bursts of speed, and this enables it to catch small fishes, together with a variety of crustaceans, on which it principally feeds.

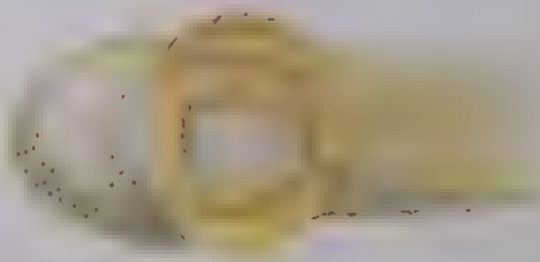
The sedentary nature of the lumpsucker also makes it vulnerable to otters on the west coast of Scotland, and to the activities of spearfishermen, a small but destructive minority in Britain. Even though it is not the object of a full-scale fishery in this country, the lumpsucker may be commercially valuable to anyone who catches it, for its roe is eaten as a cheap alternative to caviar: lumpfish caviar (mostly imported) is sold in almost all delicatessens. However, the lumpsucker does not appear to suffer as a result of commercial exploitation. There is happily no suggestion that this interesting species is on the decline. During the summer months both males and females are relatively easy finds for the diver in our coastal waters.

Looking at lumpsuckers



* in breeding coloration

Left At the end of the breeding season the male lumpsucker returns to his usual non-breeding colours This one demonstrates the use of the sucker



close-up of sucker

Below. A male lumpsucker in reddish breeding coloration Females are seen less often as they return to deeper water soon after spawning

THE OLIVE FAMILY IN BRITAIN

Though the olive tree is rarely seen in Britain the family of plants to which it gives its name includes some familiar favourites popular garden ornamentals such as lilac and forsythia and, surprisingly, our own native ash and privet.

Known to botanists as the Oleaceae after *Olea*, meaning 'olive', the olive family is a large and widespread group of plants with about 600 species throughout both the Northern and the Southern Hemispheres. Among the more familiar members are lilac, forsythia and jasmine as well as ash and

Above: One of the largest members of the olive family, our own native ash in fruit

Right The arrangement of flowers into panicles is shared by many members of the family–including lilac.

Family features

[illegible]

In [illegible] the flower [illegible] form of a showy panicle [illegible] flowers arranged [illegible] reduced one. In the main [illegible] bisexual male and [illegible] in the same structure the style [illegible] stigma and the stamens [illegible] to four. There are usually four [illegible] some species have as many as [illegible] petals are borne within a [illegible]

The olive family is at its most [illegible] range of its fruits. The familiar dry [illegible] fruit (known as a samora) of the ash represents one extreme of this range. The fruit consists of a single seed attached to a pale brown, membranous wing. The wing twists slightly on drying, the resulting shape resembling a propeller blade which, when caught by the wind, causes the seed to spin away from the parent plant. The fruits of the olive jasmine and privet, however, are very different, consisting of fleshy berries or drupes. They are dispersed mainly by birds. Another variation is shown by forsythia and lilac, their fruits consisting of hard capsules which open on drying, leaving the seeds to be shaken out by the wind.

Native tree Among the most familiar

The trees

As well as our native ash several other species grow in Britain, all introduced here for their ornamental qualities. The olive, however, is rarely hardy enough to grow here and is known to most people only by its fruits, now for sale

members of the olive family in Britain is the common or European ash. This native species often occurs as a hedgerow tree and, more rarely, forms the climax vegetation on limestone soils. A good example of this can be seen in the Derbyshire dales, where the sides of the deep valleys are covered by natural ashwood.

A further 60 or so species of ash grow in various parts of the world, some of which have been introduced to Britain for their ornamental qualities. Perhaps the most striking of these introductions is the manna ash from southern Europe and western Turkey. It forms a dense, round-headed tree with dark

The privets

Two common privets. Flowers and fruits of our native species are shown left and below, respectively

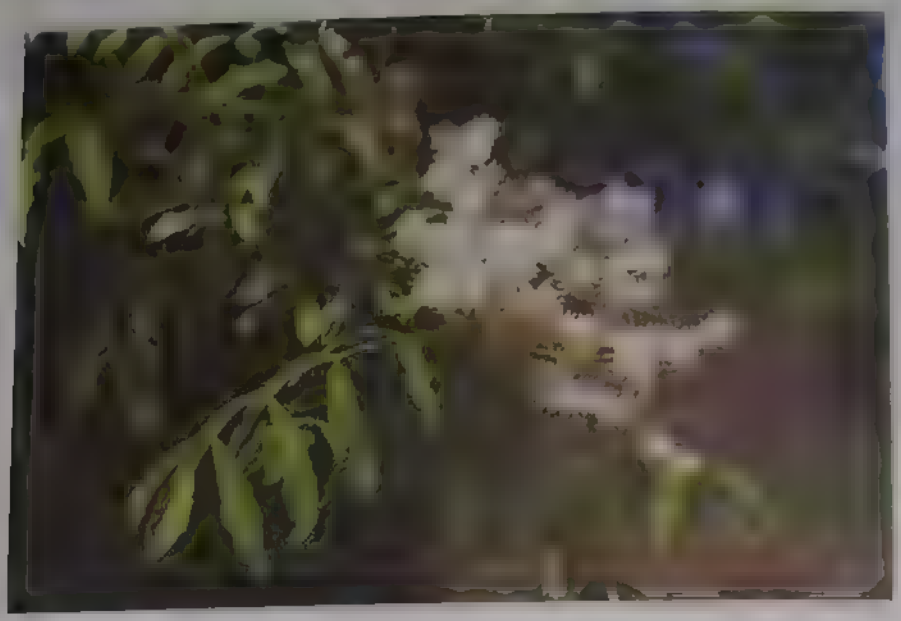
Other ornamentals

The olive family supplies some of our prettiest ornamental shrubs, from the winter-flowering jasmine to forsythia, which blooms in early spring, and on to lilac and common jasmine, which both start to flower in early summer

green leaves and is at its best in May when it bears large panicles of whitish flowers. A third species of ash, which is sometimes seen planted as a street tree, is the narrow-leaved ash from the western Mediterranean area and North Africa. It closely resembles our own native ash but differs in its narrower leaflets, brown buds and dark grey bark.

Exotic olives The other tree in the olive family sometimes seen in Britain is the olive itself. Native to the Mediterranean, it has been cultivated there since prehistoric times and today it plays an essential role in the economies of such countries as Spain, Greece and Italy. In Britain, however, the tree is not very hardy out of doors since it cannot withstand an average winter temperature below 3°C (37°F). In this country, therefore, it can be cultivated only in the mildest areas. Chelsea Physic Garden, for example, has an olive tree some 7m (20ft) high, which frequently produces ripe fruit.

The olive is a small, slow-growing, evergreen tree capable of living for 1500 years. It



has lance-shaped leaves up to 8cm (3in) long, which are green on their upper surface and silvery below. The flowers are small and white, and the single-seeded fruit that develops is green at first, turning dark blue or purplish on ripening

The fruits are usually harvested at one of two different ripening stages: when straw-coloured for green table olives, and when black and ripe for cooking purposes or oil

Privets native and foreign Apart from the European ash just one other member of the olive family is native to Britain–the common privet. Familiar to most people as a garden hedge, this semi-evergreen shrub is fairly common in the wild in most parts of the country, though it is considered to be native only from Yorkshire southwards. About 16 species of privet are hardy in this country and, although they are not among the most attractive of garden shrubs, a few of them are quite striking in flower. This is particularly true of *Ligustrum lucidum*. Native to China, this plant grows to become a large shrub, or sometimes a small tree, reaching a height of 5m (16ft). During August it is covered with long panicles of white flowers, 15-20cm (6-8in) in length.

Ornamental jasmines One of the most decorative members of the olive family is jasmine, a group of plants varying from shrubs 3m (10ft) tall to small plants barely 25cm (10in) in height; some are vigorous climbers. The flowers are sweetly scented and tubular in shape; they are usually yellow or white.

Of the many species of jasmine in the world, only a few are hardy enough to grow in Britain, and of these the winter-flowering jasmine is the most common. Its popularity is due to two reasons: during dull winter months it produces a colourful display of yellow flowers on bright green twigs; and it is one of the hardiest jasmines, being able to withstand extremes of both climate and soil conditions.

The climbing jasmines are perhaps the most spectacular of the group, providing an abundance of flowers throughout the summer. One such is the common jasmine, thought to have been introduced to Britain as long ago as 1548. White flowers are borne in terminal clusters from June to September

Forsythia and lilac Of all our early-flowering shrubs, forsythias are among the most popular–as witness the number of gardens ablaze during March and April with the daffodil-yellow flowers of this shrub. The flowers are borne on the previous year's wood and appear before the leaves begin to expand.

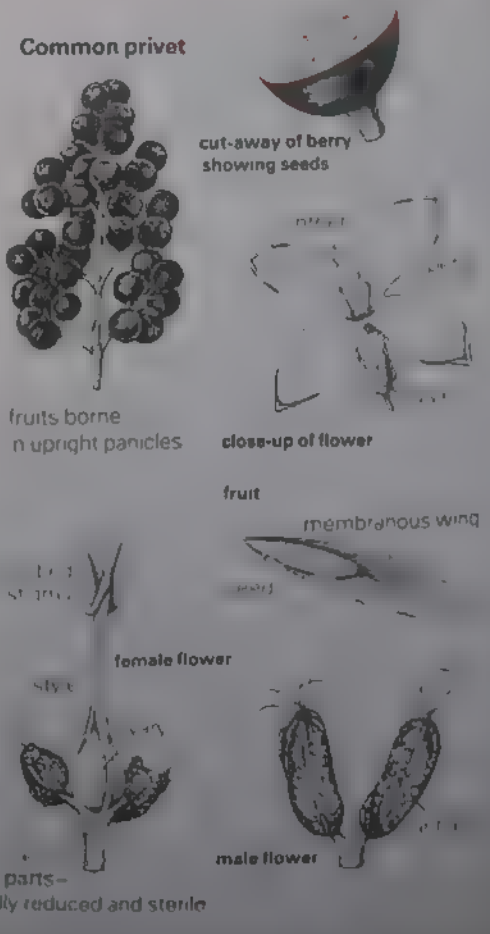
Lilac probably ranks second only to forsythia in its popularity as an ornamental shrub, its fragrant panicles of pastel-shaded flowers marking the arrival of early summer in a great many parks and gardens. They form a group of deciduous shrubs, usually with opposite leaves, some of which are pinnately lobed.

Most lilacs grown in Britain are selected colour forms of the common lilac from eastern Europe. This shrub, which can grow to a height of 7m (23ft), was introduced into Britain in the 16th century and has been popular ever since. Some smaller lilac species are also grown in this country; for example the Chinese *Syringa microphylla*, a shrub attaining 2m (6ft). This small-leaved species has a more delicate appearance than the common lilac and often has a second flowering in September

Above. A manna ash in flower. The leaves have the same pinnate arrangement as the common ash, though they are a darker green, but the flowers are startlingly different. Whereas on the common ash they are small and barely noticeable, on the manna ash they are borne on large panicles, making this tree the most attractive species of ash seen in Britain

Flower and fruit structures

The various members of the olive family show a much greater diversity in flower and fruit structures than is found in many other families. Comparing our two native members, for example, privet has four-petalled flowers, with both male and female parts present and the fruits are fleshy berries. In ash the male and female parts are petalless and usually separate, and the fruits consist of a seed and a membranous wing.



MAMMAL LIFE ON BRITISH ISLANDS

Many of the various islands dotted around the British Isles have developed distinctive mammal populations. How and why they have evolved and to what extent their numbers are changing is not always clear, but they are of great interest to mammal enthusiasts.

There are three main ways that mammals can reach an island. They may swim to it, though this usually requires the island to be close to a neighbouring land mass. They may be carried there often with the help of man otherwise on drifting wood, or, in the case of bats, blown to the island by strong winds. Finally they may be present on the island because at one stage the island was joined to the mainland and only separated later by the rising of the sea, leaving an isolated population. This last method was probably the one taken by many mammals we see today in the British Isles.

As soon as isolation from the mainland occurs, there are possibilities for populations of a particular species to diverge from others of that same species. However, this only occurs if environmental conditions are different in the two localities so that the selection pressures on the two populations differ; or if the population is very small so that simply by chance the individuals may be genetically different from those of the other population.

Random genetic drift The latter process is called random genetic drift and requires some explanation. It is perhaps best understood by considering the following example. If you take a classroom of 20 children and measure the height of each child, you can arrive at an average height for the group. If two of these children at random are now separated (with no attention to their height or any other characteristics), and you now measure the height of the two groups, the first group of 18 is likely to have an average height very similar to that obtained previously for the complete class of 20. However, the chances are that the group of two will have an average height that differs more markedly from the average for the class as a whole.

Above: There are no truly wild goats in Britain but feral herds live in remote areas including sands

Left: The black rat enters islands through ports

Left. A rabbit grazing the turf among the clumps of thrift on Skomer island, Dyfed in Wales. The prolific rabbit population on this island means that the turf is grazed hard which allows numerous species of low growing flowers to thrive

Right: The map shows areas where there are noted island mammal populations. They vary in differing degrees from their mainland relatives. Some, such as the greater and lesser white-toothed shrews, are absent from mainland Britain and occur only on islands, in this case the Channel Is. and the Isles of Scilly, and on mainland Europe. In others, island and mainland sub-species exist, distinguished on the basis of size, colour, bone and tooth structure. In the case of the mountain hare the differences are more apparent in winter

So it is with populations in general. If an island has a population of only a few individuals, it is likely that it will differ from the larger population from which it is derived. Height is partly determined by genes and the variation in the genes of individuals of a population. Natural selection can only act upon the genes that individuals possess, and so the genetic constitutions (the assemblage of genes) of a population will dictate to some extent how it will evolve.

If that population is isolated and the evolutionary route differs greatly from the parent population, then a new species may be formed. This has occurred for example with a number of mammals on small isolated offshore British islands -the white-toothed shrews from the Isles of Scilly and the Channel Islands; the Orkney vole from Orkney, off the north of Scotland; and the Soay sheep from St Kilda, off north-west Scotland. These species are today quite distinct from their nearest mainland relatives.

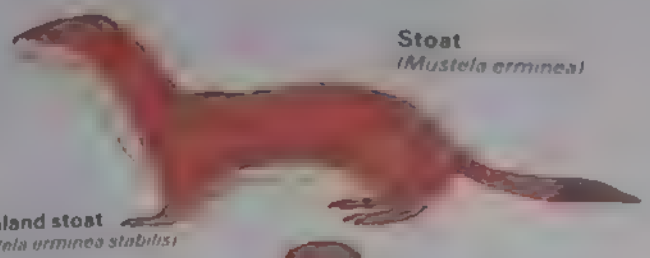
Why are they there? It is often a problem determining why one but not another may be present on islands. The mammals of most of our small offshore islands probably arrived with the help of man. Many of the islands along the western seaboard of Britain and Ireland have their own population of wood-mice (sometimes forming distinct island races, as on St Kilda and Fair Isle), and these almost certainly arrived in grainstores with human settlers.

House mice too are likely to have arrived on islands in sacks of grain and other materials.

Below. An unusual picture of a swimming hedgehog. Although it can swim to safety from a pond or swimming pool, it is rarely found on islands far from the mainland. In south-west Ireland it occurs on a few small inshore islands, usually in sheltered bays, but it never reaches the islands well offshore

Even islands or rocks inhabited only by lighthouse keepers have their house mouse populations, presumably established in this way. House mice occur only on islands with human habitation: St Kilda, and Great Blasket island off south-west Ireland, both had populations when they had human communities but soon after the islands became uninhabited these populations became extinct. It seems that the food and or shelter which man inadvertently provides is a

Island mammals

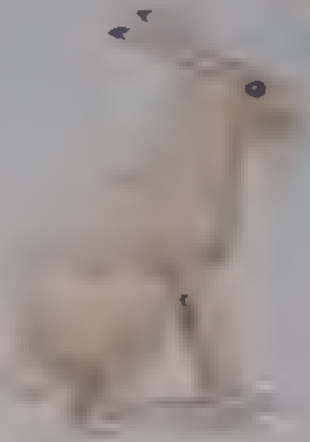


Stoat
(Mustela erminea)

Mainland stoat
(Mustela erminea stabilis)

Above The Irish stoat, a sub-species solely represented on the Irish mainland, is distinguished by its darker upperparts and an irregular, smaller area of white fur on the underparts

Irish stoat
(Mustela erminea hibernicus)



Mountain hare (winter)
(Lepus timidus scoticus)

Mountain hare
(Lepus timidus)

Irish hare (winter)
(Lepus timidus hibernicus)

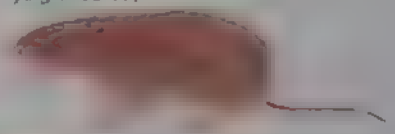
Above The mountain hare of Scotland and northern England turns white in winter, while the slightly redder Irish race does not (even when in experiments it has been transported to Scotland)

House mouse
(Mus musculus)

Mainland house mouse
(Mus musculus)

Bull Is house mouse
(Mus musculus jamesoni)

Above. The flavistic (yellow-coloured) population of house mice from North Bull Is is a different colour from mice on the Irish mainland



Bank vole
(Clethrionomys glareolus)

Mainland bank vole
(Clethrionomys glareolus glareolus)

Bank vole (Mull)
(Clethrionomys glareolus alstoni)

Above and left Five island sub-species of bank vole are recognised in the British Isles from their external appearance and bone structure. They differ from the Continental species and occur on the mainland and on the islands of Mull, Skomer, Jersey and Raasay.

Orkney/Guernsey vole
(Microtus arvalis)

Orkney vole (southern)
(Microtus arvalis orcadensis)

Orkney vole (northern)
(Microtus arvalis orcadensis)

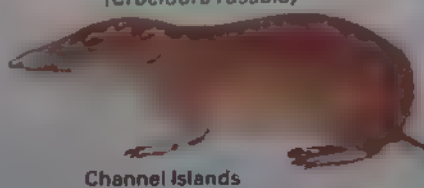
Skomer vole
(Clethrionomys glareolus skomerensis)

Above and left Five island sub-species of bank vole are recognised in the British Isles from their external appearance and bone structure. They differ from the Continental species and occur on the mainland and on the islands of Mull, Skomer, Jersey and Raasay.

Guernsey vole
(Microtus arvalis sarnius)

Above In the British Isles this species is confined to the islands of Guernsey and Orkney although it occurs elsewhere in Europe Individuals from the northern Orkney islands of Sanday and Westray are paler than those from the southern islands of mainland Orkney, South Ronaldsay and Rousay

Greater white-toothed shrew
(Crocidura russula)



Channel Islands

Above: In the British Isles this species is confined to the Channel Is of Alderney, Herm and Guernsey where it is the only shrew species present

Lesser white-toothed shrew
(Crocidura suaveolens)

Isles of Scilly

Above. In the British Isles this species is confined to Jersey, Sark and the Isles of Scilly. It is the only shrew species present (with the exception of Jersey)

Left: An island wood mouse. Separate sub-species of wood mouse are found today on St Kilda and on the Shetland Isles of Foula and Fair Isle, there are also slight variants of the mainland wood mouse on a number of islands such as Lewis, Rhum Raasay, Mull and the Channel Islands, but their differences are not sufficient for them to be classified as sub-species

Right: The mink loses no time in establishing itself on islands if it is released or manages to escape from mink farms. It has spread to a number of Hebridean islands without farms, presumably by swimming. It is a good swimmer and climber and is well suited to conditions found on many of our offshore islands. Its presence in some cases causes great concern to ornithologists because of its habit of taking young birds

crucial factor to the survival of house mice on islands in winter.

Some mammal species have been purposefully introduced. The rabbit, for example, occurs on nearly all offshore islands where man has lived or frequently visits. It was probably originally introduced for meat. Other species such as the mink have been introduced by man and bred in captivity, but escapees have colonized neighbouring areas. Thus mink are found on islands in the Hebrides, where they pose a potential threat to ground-nesting birds, particularly the eider duck and black guillemot on which they prey.

There are few cases of mammals which have arrived on islands by natural means. Some islands such as Lundy in the Channel and the Shiant Isles in the Minch have brown rat populations which may have come ashore on drifting timber from shipwrecks. The brown and black rats have caused widespread damage to native populations worldwide, but most of our uninhabited islands are rat-free, probably because of the harsh winters and lack of food. There are many records of rats coming ashore on islands, occurring in abundance for a year or two and then dying out.

Island influences Islands have various characteristics which can profoundly influence the ecology of their mammal populations. Most of the islands around Britain and Ireland occur off our west and north coasts, facing the Atlantic. They therefore receive an oceanic climate with mild winters and relatively cool summers. If they are some distance from land they tend to receive less rainfall than the mainland because there is less high ground around which cloud can collect

Below: The famous Soay sheep of St Kilda, the only truly wild sheep to be found in their natural state in the British Isles, although there are numerous flocks kept in mainland parks.

Unless they are sheltered from other land masses they are also windy places, and this often has consequences for the amount of vegetation cover Trees are uncommon on small offshore islands

Because islands are bounded by the sea mammals rarely have the opportunity to disperse, so that if conditions are unfavourable they cannot move elsewhere. This has probably strongly influenced how island populations exist–their body size, number of young and length of time they live in relation to their mainland counterparts

Most island races of mice, for example, are larger than their mainland counterparts. It is the same with many other species. Various explanations have been put forward lack of ground predators such as stoats and weasels, enabling them to grow bigger without risk of predation (although gulls and skuas also feed upon them); greater competition between individuals within a species so that larger individuals are likely to be dominant over smaller ones, or in some cases animals may have been brought inadvertently from populations further north where the species is larger anyway. However, the fact that individuals cannot escape unfavourable conditions may be the principal reason why they tend to be larger on islands, since larger animals can carry around proportionately more fat

Left The European otter which is equally at home on land and water Swimming long distances as an agency to colonize an island is a method that few species seem capable of using Mink have spread to a number of Hebridean islands without mink farms, presumably by swimming, and otters have probably done likewise to reach Shetland, Orkney and the Outer Hebrides However, both these species are strong swimmers, and most other mammal species are probably only able to cross very narrow straits of water

Some species are adapted to swim–the grey and common seals for example, and offshore islands afford important and safe refuges from human disturbance for them to haul out and to pup

Changing populations We know rather little about the detailed ecology of island mammal populations, but studies of rabbits and mice have indicated that populations may fluctuate greatly in size from year to year. A favourable summer may provide a boom in births with the population rising dramatically Because individuals cannot disperse, there may then be intense competition and when food becomes scarce a high mortality, so that the population crashes once more. Recurring outbreaks of myxomatosis amongst rabbits on islands may be a consequence of high densities after favourable conditions followed by mass mortality and breeding failure as the disease spreads quickly

Generally speaking, the smaller the island, the fewer habitats it possesses and the more isolated it is, the fewer the number of species that occur upon it. On small islands the chances of competition are greater should two similar species arrive there. This may explain why the bank vole and field vole occur on large islands such as Skye, but only the former on Raasay and Skomer, and only the latter on neighbouring Skokholm. When only one of the two species occurs, the lack of competition may allow it a wider range of habitats. For example, the house mouse–the only mouse on Skomer–occupies bracken habitats used by the wood mouse elsewhere, while closely related species such as the stoat and weasel, and the pygmy and common shrew, are only rarely found together.

Below right. The Skomer vole, a sub-species of the mainland bank vole. On the island of Skomer off west Wales it lives in tall bracken and brambles, a habitat elsewhere occupied primarily by field voles. The Skomer vole has creamy markings on its underside in the winter months

TAMARISK BY THE SEASIDE

To those who spend their holidays along the south coast of England the fresh green, feathery branches of shrubby tamarisk are a familiar sight.

The slightly exotic appearance of tamarisk suggests that it is not native to Britain, and this is indeed the case. There are just over 50 species of tamarisk distributed through the warmer temperate regions of Europe, North Africa and Asia. About six different species are cultivated in Britain, of which two have become naturalised along the south coast of England and up the east coast as far as Suffolk.

Most tamarisk species are shrubs, with age sometimes forming small trees, and have characteristically feathery branches bearing minute scale-like leaves crowded together on the stems. The flowers are minute and borne clustered in short racemes. Each has four or five sepals and petals, and the same number of stamens. The stamens are attached to a basal disc of tissue, the shape of which is one of the most important clues to identifying the different species. The petals are white or pink –occasionally reddish. There is just a single pistil with three or four stigmas and the fruit is a capsule which, when ripe, contains many seeds, each of which bears a tuft of hairs at its apex

Tudor introduction Tamarisk was first introduced into Britain during the Tudor period, apparently from Germany. In those days it was regarded as a 'sovereign remedie against the great and undurate passion of the spleene'. Other writers mention its use in treating 'disordered livers and hard spleen'

Today, however, the main use of tamarisk in Britain is as screening or hedging plants, and as windbreaks. They have proved themselves to be particularly useful along the south coast because of their tolerance of salty soils and salty spray

One of the advantages of tamarisk is the

Above: A stand of *Tamarix gallica* on Chesil Beach in Dorset This is the more common of the two species of tamarisk that have become naturalised along the southern and south-eastern coasts of Britain

Below: The white to pale pink flowers are borne in a particular type of arrangement called a raceme, in which the flowers are clustered in a spike, the ones furthest away from the tip of the spike opening before the ones further up

extreme ease with which it can be propagated In Cornwall the recommended method is to cut a piece of tamarisk the size of a walking stick in early winter, sharpen the base to a point and then drive it into the ground where the new plant is required. The following spring it will sprout

Common species The most common species in Britain seems to be *Tamarix gallica* though the difficulty of identifying the different species means that a number of records use different names for our naturalised species The natural range of *T. gallica* extends from north-west France, through western Europe, to North Africa It can form a small tree about 8m (25ft) in height and has blackish-brown to deep purple bark. The leaves are tiny (1·5-2mm long) and hairless. The flowers are white tinged with pink and are aggregated into slender racemes 2-5cm (1-2in) long. The petals, which are about the same length as the leaves, are quickly shed once the flower opens but, because large numbers of flowers are produced over about a month, the plant is still a spectacular sight in bloom

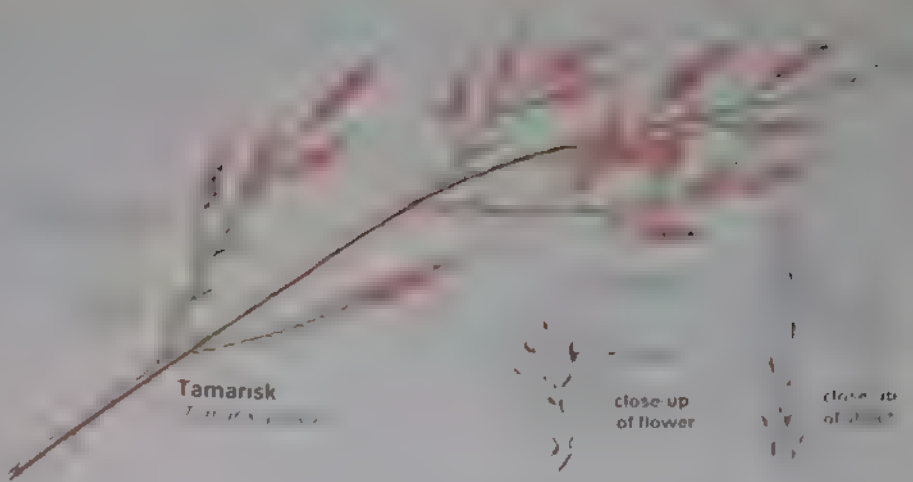
The flowering period for *T. gallica* is usually late spring on wood produced the previous year, though it can also flower later than this At one time the flowering period and the fact of whether the flowers appeared on wood produced during the current or the previous season's growth were major features in identifying species. Recently, however, the validity of this has been questioned, and it now seems that a single species may show both patterns of flowering

In 1841 a plant called *Tamarix anglica* was described along the south coast of England, and it is still often treated as a distinct species. However, it is undoubtedly very closely related to *T. gallica* and recent work suggests that they are probably the same species

Others in Britain Another species *T. gallica* has often been confused with is *T. africana* However, unlike the case of *T. anglica*, *T. africana* is a distinct species. It comes from south-western Europe and North Africa, and like *T. gallica* has become naturalised along the south coast of England. It is very similar to *T. gallica* and, apart from its slightly broader inflorescence, can be separated from it only by technical differences.

A species occasionally seen in Britain, most often in cultivation along the south coast, is *Tamarix chinensis*. This plant has a very dense habit of growth with pale green foliage borne on slender branchlets. The flowers are bright pink in bud but much paler when they have opened. They are carried on racemes about 5cm (2in) and appear in May. As its specific name suggests, *T. chinensis* is native to eastern and central Asia, and is thought to have been introduced to Europe some time during the 18th century.

Among the other species of tamarisk cultivated in Britain is *T. hispida*, a deciduous shrub that grows to a height of 1m (3½ft). Both



Right. The only sure way to identify a tamarisk species is to dissect a flower and extract the stamens and basal disc to which they are attached (collectively known as the androecium). Here anthers are shown only for *T africana*

leaves and young branches are covered in down, and pale pink flowers are borne in late August and September This species is not reliably hardy, unlike *T. ramosissima* (sometimes known as *pentrandra*) from the southern USSR and Asia, which has long slender branches and dense rosy-pink inflorescences

One species not seen in Britain is *T mannifera*, which thrives in deserts around the Mediterranean area. In association with certain coccid insects (scale insects and mealy bugs) it exudes an edible substance, and it has been suggested that this is the original of the Biblical manna. Other people, however, have put forward equally plausible algal and lichenous origins of manna

Below: A tamarisk hedge The wood of a tamarisk is very hard, and in warmer countries it is used for construction work. In Britain, however, its main uses are for hedging, screening and as windbreaks

COLOURFUL WATER MITES

Water mites are small, colourful creatures, their shade depending on the amount of excretory products in their bodies. They have a characteristic life-cycle with free-living nymphs and adults, but their larvae parasitise aquatic and semi-aquatic insects.

The common name, water mite, is generally used to refer to members of the Hydrachnellae, an aquatic group of mites comprising species found mainly in freshwater habitats, although a few intertidal forms exist.

Swimmers and crawlers Some 250 species have been recorded in the British Isles, and individuals can be seen all year around. Red, brown, blue, yellow or green in colour, they are generally round or oval and about 2mm long (although the largest British species is 8mm long).

The nymphs and adults often bear very long, slender and flexible 'swimming setae' on their legs, usually arranged in clumps or rows on the last three pairs. The presence or

Above: The vast majority of water mite larvae parasitise aquatic or semi-aquatic insects, each mite species choosing certain genera or families of insects as their hosts. The larvae of *Hydrachna* species, for instance, often parasitise water scorpions (above). The parasitic water mite larvae usually only survive a few days without food so it is imperative that they find a suitable host as soon as possible after hatching from their eggs.

[illegible] the [illegible] setae is a useful indicator of a [illegible] of life: mites with numerous and [illegible] swimming setae, such as [illegible] swimmers, while those [illegible] setae, like *Thiasreyalis*, are crawlers often found in temporary pools.

Parasitic life-style Water mites h[illegible] characteristic life-cycle as, with fe[illegible] tions, the larvae are parasitic and the nymphs and adults are free-living predators. Both nymphal and adult water [illegible] which are modified for [illegible] parts for piercing and sucking [illegible] includes other mites, small crustaceans and aquatic insects and their eggs.

The female water mite usually lays her pink or red eggs in clusters on the leaves and stems of aquatic and semi-aquatic plants, or on submerged stones. A transparent, jelly-like substance covers the eggs and secures them in place. (Females of *Hydrachna* species are unusual as they lay their eggs in tiny holes pierced in the stems of water plants by their needle-shaped mouthparts.)

As in all mite life-histories, the eggs hatch into six-legged parasitic larvae. The range of potential insect hosts is wide - dragonflies, mayflies, beetles and water bugs are a few examples – although the larvae of most water mites only attack members of certain families.

Finding a host On hatching the water mite larvae face the urgent and enormous task of finding a suitable host – they can only survive a few days without food. They search for, and gather round, host individuals that are about to emerge as adults. While the host moults the mites move from the pupal or nymphal case to the new adult, attach themselves by means of their mouthparts, and then begin to feed.

Usually the parasitic larvae choose the membranous areas between the insect's abdominal and thoracic segments for attachment sites; the cuticle is relatively thin in these regions making penetration, and consequently engorgement, easier.

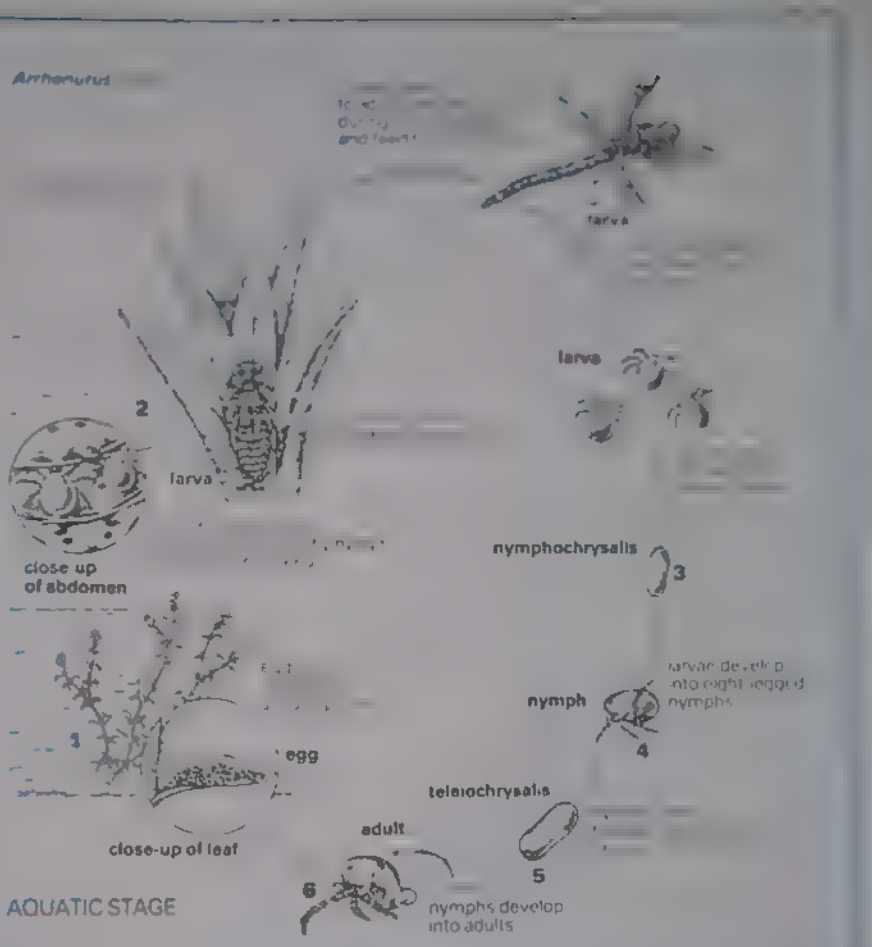
The larvae complete their feeding as the host matures; usually this takes between four and ten days, after which they detach from the host and pass through a non-active phase known as the nymphochrysalis. This is followed by the eight-legged nymphal stage then another non-active period the teleiochrysalis before the mite finally becomes an adult.

Water mite larvae that parasitise semi-aquatic insects, such as dragonflies and mosquitoes, remain attached and continue feeding when their host leaves the water. They drop off when the host returns to the water to lay its eggs or mate. Some larvae overwinter on the host insect and may stay attached for as long as ten months.

Mollusc parasites There are two alternatives to the normal water mite life-cycle. One is when the adults and nymphs are free-living predators as usual, but the larvae are not parasitic; they either metamorphose to nymphs without feeding or, as in *Pionacercus*

Water mite life-cycle

Most water mites have similar life-cycles The females lay their eggs (1) in clusters on aquatic plants where they hatch into larvae (2) A suitable host–an insect that is about to emerge as an adult–is then found As the host dives is the parasitic mite larvae move from the nymphal or pupal case to the adults, attaching themselves with their mouthparts to feed Four to ten days later the larvae drop from the host into the water where they pass through a non-active phase, nymphochrysalis (3), before becoming nymphs (4). This is followed by another non-active period, teleiochrysalis (5), and then the final adult stage (6).



develop inside the eggs and emerge from them as predatory nymphs.

The second exception to the rule occurs in certain genera of the family Unionicolidae. These water mites parasitise freshwater bivalve molluscs, snails or sponges, and it is the nymph and adult stages that are parasitic, not the larvae. Some Unionicolidae are transient parasites, that is they are free-living for most of their life, and only enter the host during the inactive nymphochrysalid and teleiochrysalid phases Others are resident parasites, living on the host for at least one of their active stages (nymph or adult).

Unionicola aculeata is a transient parasite associated with a wide range of freshwater molluscs. The female lays her eggs in batches of 25-30 in the loose connective tissue below the mollusc's skin As soon as the eggs hatch the larvae leave the host usually in the spring They return to the host in early summer and work their way into the mollusc's gill tissues where they develop into and pass through the nymphochrysalid stage The emerging nymphs then leave their host and lead a free-swimming predatory life During late summer or early autumn they re-enter the mollusc and form the teleiochrysalis. The predatory adults leave their host as soon as they emerge, which is in about October.

Mussel hosts Resident parasites of the Unionicolidae are specific in their choice of host. *Unionicola intermedia* almost exclusively occurs in the duck mussel, whereas *Unionicola ypsilophora* chooses the swan mussel. A particular host individual may be parasitised by more than one species of water mite at the same time, however. Fortunately though, the contrasting behaviour of parasite species minimises competition between them as each species prefers to infest a different site in the mollusc.

Females lay their eggs in the host's tissues: on hatching the larvae leave the mollusc and lead a free-living existence. This helps to prevent over-exploitation of a host individual After emerging from their respective chrysalid stages the nymphs and adults wander about on the host in search of suitable sites for feeding themselves

Below A water mite (*Arrhenurus* sp) with its eggs in an aquarium Water mite eggs are usually pink or red in colour, and are laid in clusters on the stems and leaves of aquatic plants When in an aquarium, however, the eggs are often fixed to the glass sides

Salt water dwellers Another group of mites exists, which live in water but do not classify as true water mites They are the *Halacaridae*, found in salt water where they crawl, rather than swim, clinging tightly to the substrate with their well-developed claws. Their life-cycles differ from those of water mites as they have free-living larvae, and three active nymphal stages, with no resting or transformation phase at all

THE PIED FLYCATCHER

In the western oakwoods of Wales, the pied flycatcher is a familiar breeding species, and often it is the commonest bird there during the summer. But it is slowly expanding its range, especially with the help of extensive nestboxing schemes.

Over most of Britain, pied flycatchers are not nearly as common as their near relatives, the spotted flycatchers. Only in the western oakwoods of Wales are they a really common breeding species. They are small birds, about the size of great tits; the breeding males, in full plumage, are absolutely unmistakable with their striking black and white markings.

During their summer visits to Britain, pied flycatchers prefer woodland with a good tree cover at the canopy level, but without much of a shrub layer. Such open woodland is typical of the grazed sessile oakwoods of the south-west, much of Wales and some other parts of upland Britain. The males arrive on the breeding grounds in mid-April, often while

Above. The vivid breeding plumage of the male pied flycatcher: black upperparts are interrupted by striking white wing stripes and a white throat patch extending to the sides of the neck

Right: The female is brown and white. This is also the appearance of both sexes of pied flycatchers in autumn.

Pied flycatcher (*Ficedula hypoleuca*) Summer visitor to woodland with nest holes and little or no shrub layer Length 12 5cm (5in).

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These are always holes generally in trees
pied flycatc[illegible]
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id pairs are quickly formed

The birds build their nests of the s[illegible], bark stripped from honeysuckle stems, and can complete them in [illegible] than 48 hours Th[illegible] female does most of the incubation [illegible] takes about 12 days starting with the penulti mate egg The young remain in the nest for 14 16 days and fledge as spotty young birds looking like young robins or spotted flycatch ers. Although they seem to stay within a few miles of the breeding site for several weeks while the adults complete their total moult both young and old birds are almost im-possible to see, and probably spend their time high in the tree canopy

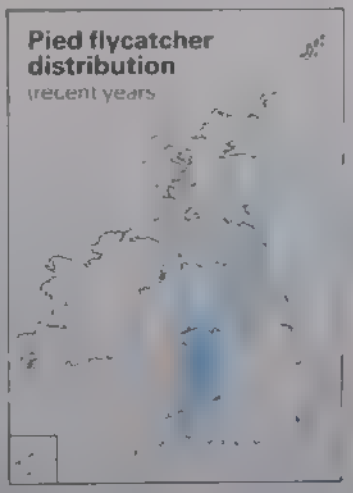
Catching 'flies' For most of the time, pied flycatchers feed on flying insects, which they take on the wing. They use convenient perches in the woodland, from which they make athletic, darting forays to catch moths and flies, returning quickly to the perch to watch for more prey The early arrivals may find the weather so cold that hardly any insects are flying and have to feed on the ground, catch ing such creatures as spiders and ground-

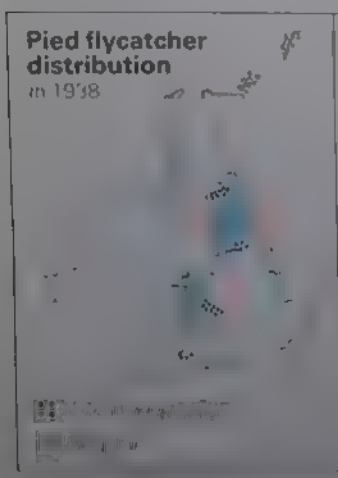
dwelling insects such as beetles, bugs and many larvae

The young, in the nest, are fed almost exclusively on insect larvae. These may be moth caterpillars feeding on the oaks, or they may be sawfly larvae. In many years there seems to be a super-abundance of these creatures, so that the oak trees may even be partly defoliated: in such circumstances, the youngsters invariably fledge successfully. In other years, when there are few caterpillars or larvae, or if there has been heavy rain washing them off the trees, fledging success may not be very great

Ringing results It is easy to study breeding pied flycatchers in great detail, for they very readily breed in conventional nest boxes, and many studies have been undertaken in Britain and abroad. In addition, they can safely be handled by ringers and marked to make the different individuals recognisable. Recaptures of adult birds in later years have shown that the males are very faithful to their breeding areas, and may come back to nest in exactly

Above. This alder wood in Dumfries, with its delightful stream, has a regular summer population of pied flycatchers. The habitat is extremely suitable, with virtually no shrub layer





The peculiar distribution of the pied flycatcher in Britain, with hardly any breeding records in the south-east, has long puzzled birdwatchers, for there are many pairs breeding in woods in the Netherlands Various reasons have been proposed, but the true explanation has yet to be proved The author favours the theory that the woodlands remaining in south-eastern Britain are probably, on the whole, too thickly grown, with too rich a shrub layer to attract the species. In many areas where they do breed, the nest box schemes run by conservationists and naturalists' trusts have helped to maintain the numbers. At the same time the range has expanded.

Many [illegible] are much more [illegible] different place in [illegible] more than a hundred miles distant from the previous year's nest Recaptures of birds ring[illegible] nestlings show that the young ofte[illegible] very great distances one Yorkshi[illegible] youngster was found in a Dr[illegible] later year!

Ringing has also made it possible to chart the birds' migration routes in [illegible] Birds from Britain, Scandinavia and [illegible] Russia are found in the autumn in northern Iberia, mostly in northern Portugal Obviously this is the important stop-over point on the migration southwards Here they set up defended feeding territories for a few weeks as they put on weight for their further flight south to tropical West Africa

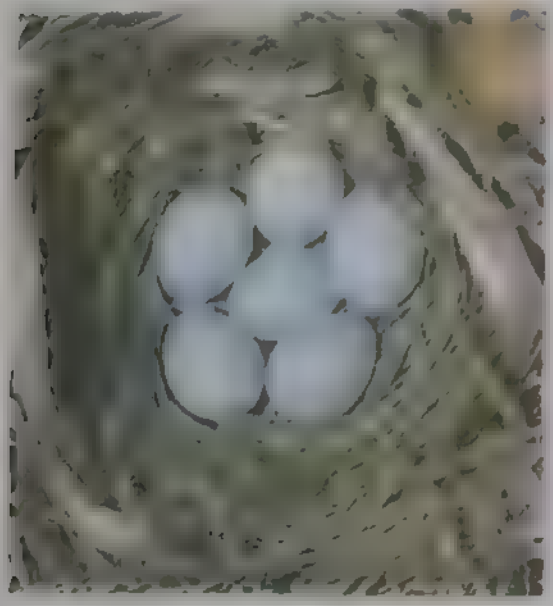
Autumn migrants Many eastern European pied flycatchers fly westwards at the start of their autumn migration, and some of these wander off course into Britain. Light south easterly winds over the North Sea can cause large numbers of them, with other small migrants such as redstarts, garden warblers and whinchats to occur in eastern Britain, together with such exciting birds as wrynecks barred warblers and Icterine warblers. Almost always these erratic arrivals are associated with cloudy weather which obscures the stars, for these provide the most important navi-

Pied flycatchers in summer

gational information for the migrants

It has been proved that there are hardly any adult birds among the autumn arrivals that it is young and inexperienced birds that are involved. Ringing has shown that they are not doomed to die, for a number of them have been seen in later years in their normal range.

Hunted birds Even such a small bird as the pied flycatcher has, in the past, been hunted by man. In parts of Spain and Portugal, specially constructed spring traps were (and sometimes still are) used to catch them for people to eat. Each bird weighs about 15g (½oz) and they are fried, whole, after the feathers have been singed off them. International conventions on bird protection have had considerable effect over the last few decades, and this distressing practice is dying out. When Spain and Portugal have joined the European Community and the various EEC bird directives are enforced in the two new member countries, these attractive little birds will be able to undertake at least the European part of their long annual journey without fear of hunters! This could lead to the prospect of further expansion of the range.

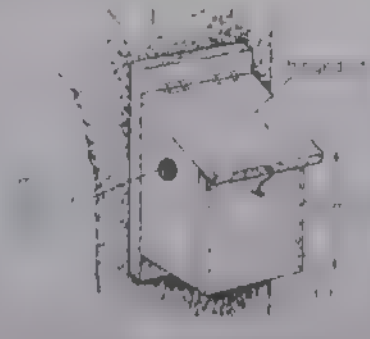


Above: A pied flycatcher in autumn plumage, in flight

Left: The nest is made of strips of honeysuckle bark. Eggs are usually laid in May. Once an early pair have their eggs, the male may desert the female and start a new territory and nest a short distance away.

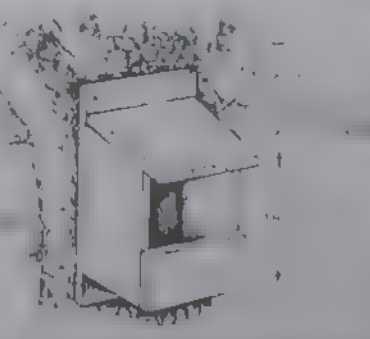
Extensive nestbox schemes

Many people put up nestboxes in their gardens, but you can achieve even better conservation results with extensive nestbox schemes in the countryside. Many hole-nesting species of birds take readily to properly constructed nestboxes. Often these are just the species that are losing nest sites as old trees are 'tidied up'. Nestbox schemes are usually designed to provide a variety of boxes within managed woodland. In such cases there should be some 10 or 20 of the small hole-nesting boxes for each of the larger ones. Ideally, you should keep a record of the occupancy of the boxes from year to year, and regularly inform the British Trust for Ornithology (BTO).

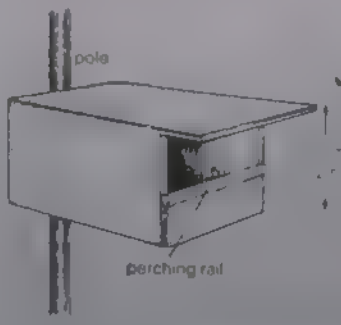


Small hole box [illegible] and many others

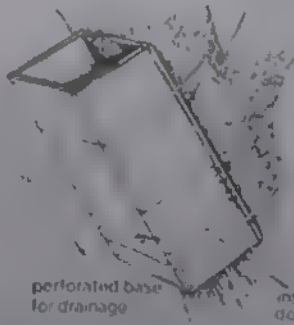
Large hole box [illegible]



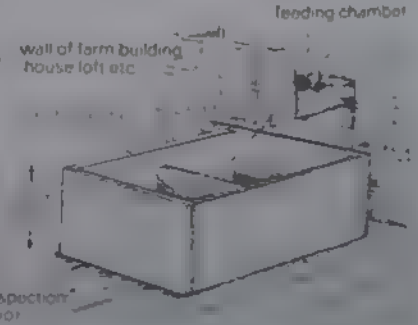
Open-fronted box [illegible]



Open-fronted box [illegible] for kestrel



'Chimney' box [illegible] stock dove



Large tray [illegible]

LEAF SHAPES IN AQUATIC PLANTS

One of the most confusing problems facing anyone seeking to identify a plant is the phenomenon of heterophylly, in which different plants of the same species have quite different shaped leaves. The most extreme examples are among the aquatics.

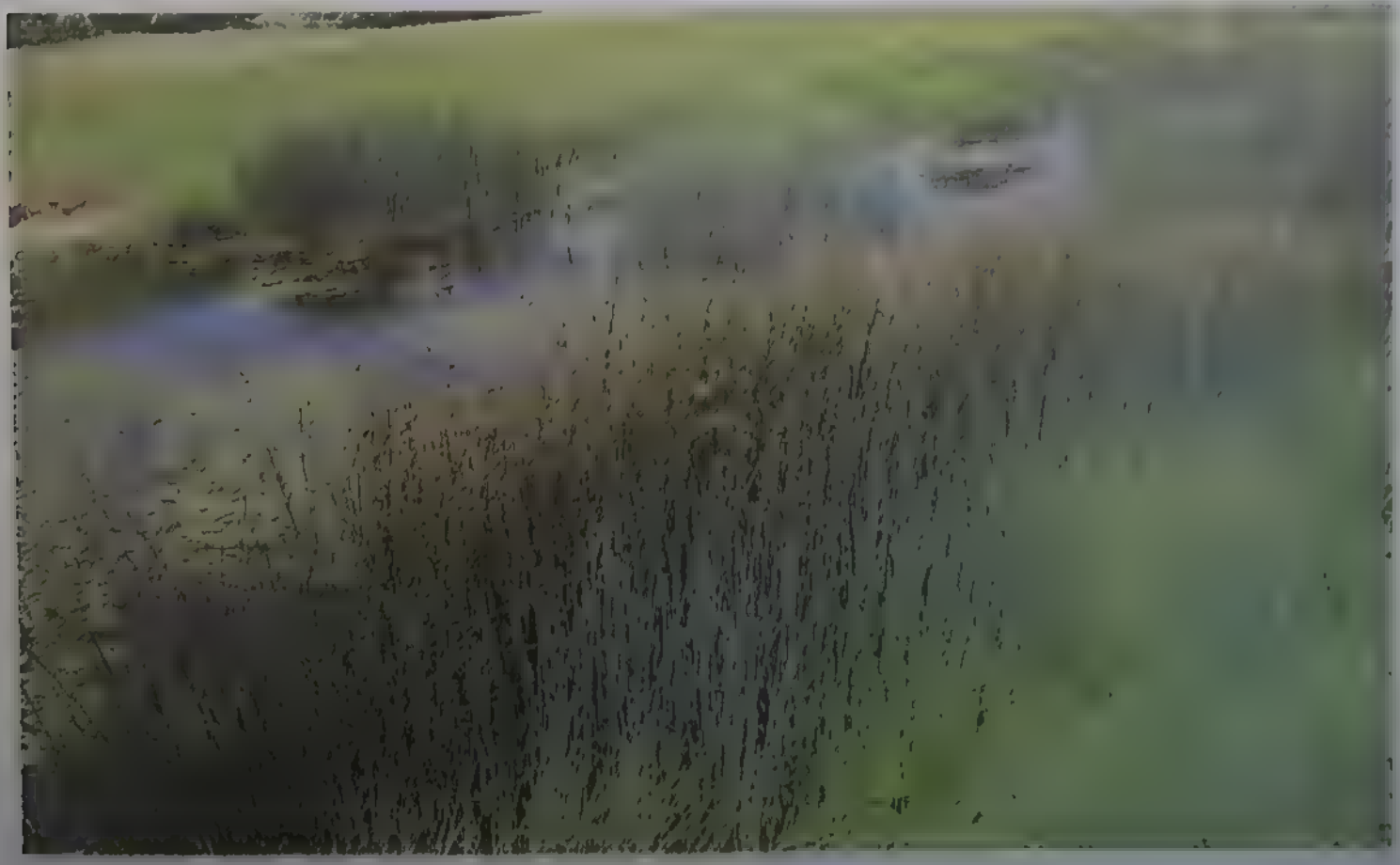
Right Clubrush (*Scirpus lacustris*) growing near the edge of a slow-flowing river In such conditions it is able to produce the upright flowering stems as well as the narrow submerged leaves visible around the base of the plants. In fast-flowing water, however, only the submerged leaves would likely be present

Below A stand of clubrush (sometimes known as bulrush) in flower A member of the sedge family, clubrush grows throughout the British Isles in lakes, ponds and rivers

Although heterophylly occurs in both terrestrial and aquatic plants, the phenomenon is far more common and pronounced – and therefore likely to lead to confusion – in the latter group. Many people are familiar with the form of heterophylly in which the shape of a plant's submerged leaves is markedly different from that of the floating leaves. But there are more general forms of the phenomenon. First, the leaf shapes may be different, though their internal anatomy remains the same. Second, the leaves have roughly the same shape, but their internal anatomy and their habit of growth are different. Third, the leaves differ in all three aspects: shape, growth habit and anatomy

The ability of some plants to develop different forms has been of great help to botanists seeking to distinguish between closely related species. On the other hand, it has created a great deal of confusion, and plants have been described as being separate species when they were simply variations on an already known species

Young and old leaves In many examples of heterophylly, the leaf variation is confined to the plant's seedling stages or to when it is regrowing in the spring from an overwintering storage organ. An example is the



white water-lily in which the first few seedling leaves are submerged and translucent, but these are soon replaced by the more familiar opaque floating leaves. In broad-leaved pondweed, which often roots in deep water, the first leaves are frequently long and thin, whereas once growth is in full swing only the broad floating leaves are produced.

In all such cases the young leaves are efficient at photosynthesising under water, so the plants have no need for elaborate stores of energy to produce new growth. Once the plants reach maturity they have no further need for their young leaves, since the broad floating leaves take over the role of photosynthesising, and they also shade out any competition.

Floating and submerged In typical heterophylly there is a permanent submerged leaf form and a floating or aerial form. The occurrence of the latter leaf form is often a response to different environmental conditions, as can be seen clearly in three examples: arrowhead, yellow water-lily and common clubrush. All three are common in clay rivers in lowland Britain. Along fast-flowing stretches of such rivers arrowhead may consist only of submerged ribbon-like leaves undulating in the direction of the flow. These leaves have very rounded tips, are a characteristic brownish-green and are often more than 2m (6ft) long and just 2cm (¾in) wide. Clubrush may also be totally submerged with flat pointed leaves, which are much narrower and a brighter green than those of arrowhead. The yellow water-lily is also likely to be represented only by its submerged cabbage-like leaves.

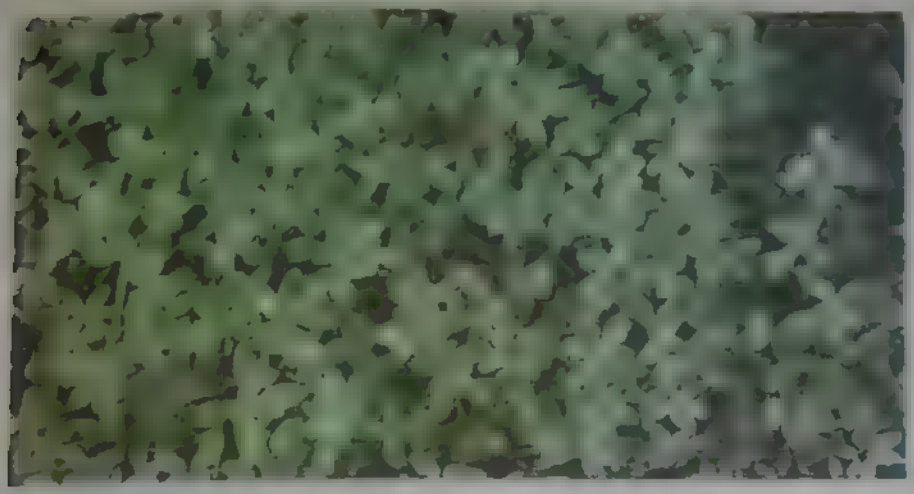
In slower flowing water, or in the still water of a pond, all three plants take on a dramatically different appearance. Arrowhead develops flat, rounded floating leaves and its characteristically arrow-shaped aerial leaves. Clubrush takes on its normal erect lush appearance, sometimes growing to a height of 2m (6ft) out of the water. Yellow water-lily produces leathery, plate-like leaves which are resistant to drying out.

Influencing factors It is often very difficult to disentangle the most important factors influencing heterophylly. Indeed, it can be dangerous to generalise too much because different factors are important for different species. Nevertheless there are some generalisations that can be made. The juvenile leaves, which usually have the submerged leaf form, are the first to appear, whatever the environment – even if the seedling has germinated on damp mud above the water level. The typical adult leaf forms, either floating or aerial, develop initially while the plant is wholly submerged, and they may remain under water. These observations suggest that, in some species at least, the plant does not respond immediately to changes in water level.

Above: Yellow water-lily (*Nuphar lutea*) showing both floating and submerged leaves. The latter are unusual in being broad and wrinkled looking rather like cabbage leaves.

Right: The typical arrow-shaped aerial leaf of arrowhead (*Sagittaria sagittifolia*), after which the plant is named.

Below: Arrowhead showing its aerial leaves and its strap-shaped submerged leaves.



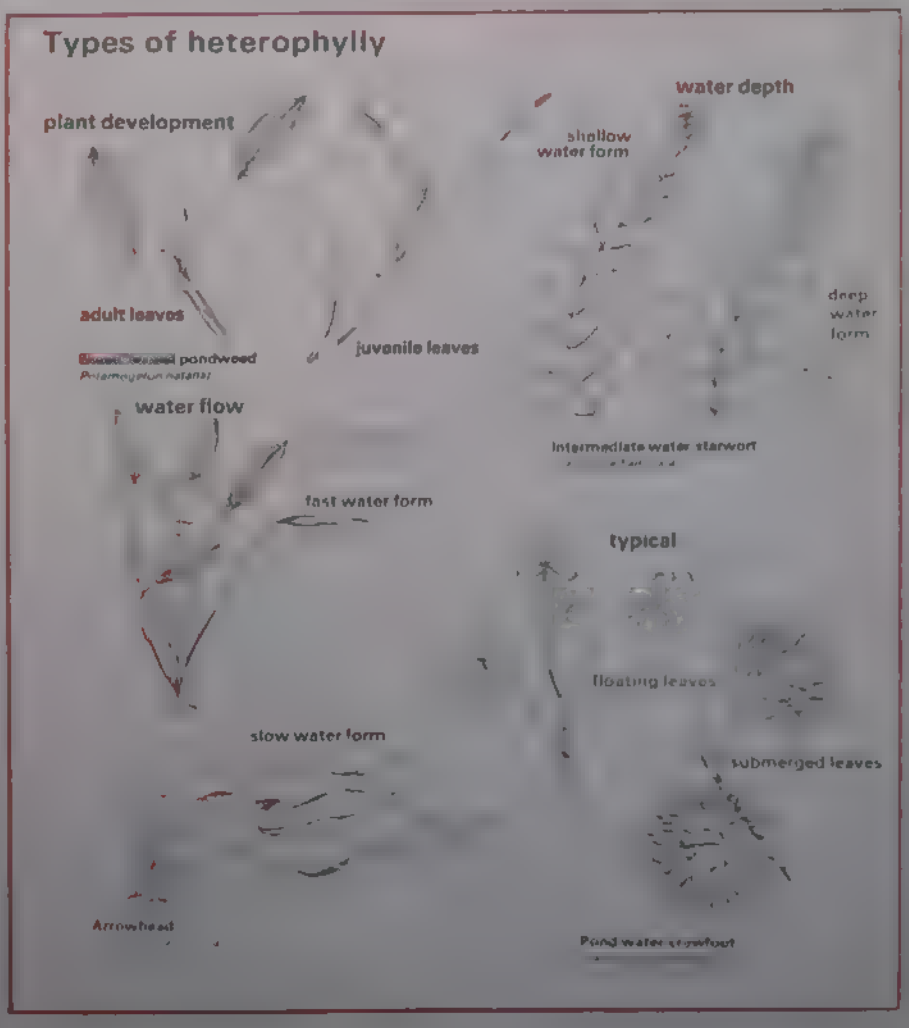
In some species changes in leaf form are easily induced. For example, if broad-leaved pondweed or arrowhead are grown in very deep water, in a shaded situation, or in water with a very low level of nutrients, then the plants retain the juvenile leaf form. If these conditions are subsequently reversed – they are given more light and nutrients – then the floating leaves appear. Shading the plants again induces the growth of linear juvenile leaves. These two species nicely illustrate how the formation of either submerged or floating leaves can be switched on or off according to external factors.

Shape and depth In some species the only external factor to influence leaf form is water depth. Consider, for example, the pond, three-lobed, common and brackish water-crowfoots. In all four species the usual submerged leaves are finely dissected, highly branched, delicate and prone to drying out. As the plants grow towards the surface of the water the broader flat floating leaves begin to appear. In deep water the number of floating leaves formed may be few, but in shallow water they may replace the submerged leaves entirely. The three-lobed water-crowfoot usually produces far more floating leaves than the other species because its favoured habitats demand this: it prefers temporary pools, rides and ditches which dry out in the summer. By contrast it is interesting to note that the river water-crowfoot, which lives in deep, permanent water bodies, does not exhibit heterophylly.

Advantages of heterophylly Clearly the ability to produce different leaves enables a plant to make use of environments in a way that other species cannot. This is demonstrated by the response of some heterophyllous plants to changes in the levels of light and nutrients. The submerged leaves are adapted to photosynthesis when conditions are far from ideal – precisely the conditions a plant is likely to encounter when trying to colonize an area where other plants are already established. By photosynthesising efficiently the plant can produce enough energy for new growth and thereby reach the surface. Once there heterophylly allows it to

Above: Floating rosettes of common water-starwort (*Callitriche stagnalis*). In shallow water both the rosette leaves and the submerged leaves beneath are rounded, but in deeper water the leaves are narrower with almost parallel sides

Right: The broad flat floating leaves of a water-crowfoot (*Ranunculus* sp.) contrasts strongly with the very fine highly branched submerged leaves usually found on the same plant



UNFAMILIAR ARROW WORMS

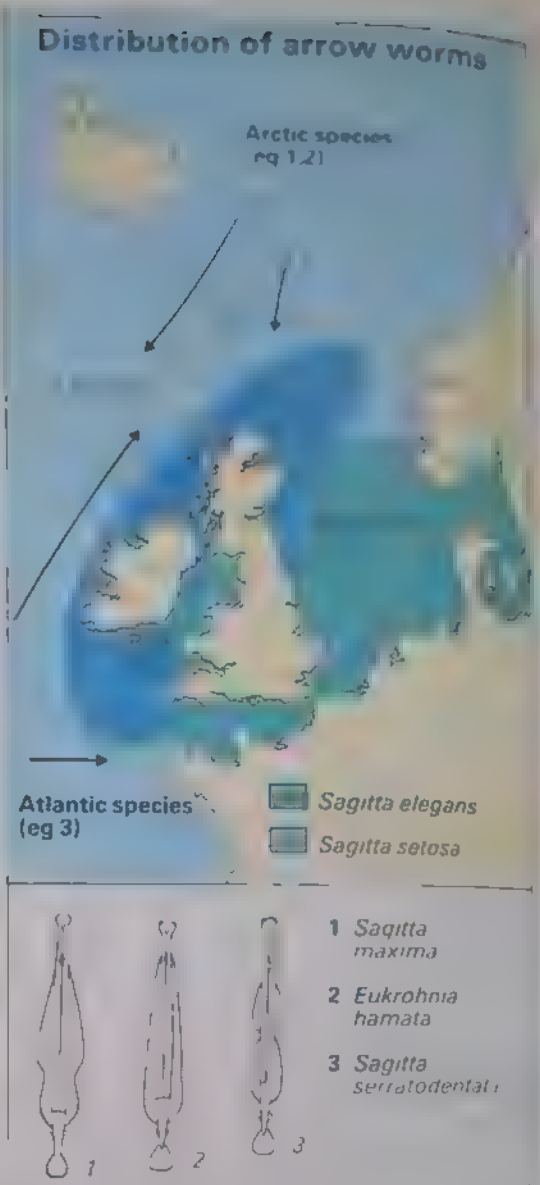
Among the myriad animals of the plankton, floating near the surface of the sea, are the arrow worms. These are transparent, arrow-shaped creatures with eyes, fins and an array of bristles with which they seize other planktonic animals to devour.

Although unfamiliar to many of us, arrow worms are among the most abundant members of the marine zooplankton the community of animal life drifting in the sea. As their name suggests they are arrow-shaped or dart-shaped, and most are transparent and typically about 3cm (1¼in) long, though some species reach 10cm (4in) in length. There are about 50 species of arrow worms and all live in the sea. Members of one genus, *Spadella*, spend much of their time on the sea-bed, attached by special suckers, but all the rest are planktonic

A worm with three sections Typically, the body of an arrow worm is divided into three sections the head, the long trunk and the short tail, each section being separated from the next by a wall of tissue

The rounded head has a pair of eyes on the dorsal (top) side, and on the underside it has a large chamber leading to the mouth. Hanging down on either side of this chamber are between four and fourteen large grasping spines or bristles. Indeed, the zoological name for the phylum of arrow worms is the Chaetognathes, derived from the Latin *chaeta*, a bristle, and the Greek *gnathos*, a jaw. The grasping spines are used to seize the prey of the arrow worm. Several rows of shorter spines, often referred to as the teeth, are curved round the front of the head, and these assist the large spines in capturing prey. In the

Above: *Sagitta setosa*, the characteristic arrow worm species of the North Sea, the English Channel, the Bristol Channel and the Irish Sea The fins are not clearly visible, probably because of the angle of vision. The ovaries appear as short white strips towards the tail end They are distinctive, contrasting with the long ovaries of *S. elegans*. In the upper left specimen, the seminal vesicles (sperm stores) can be seen at the rear end of the ovaries



As the map shows, *Sagitta setosa* is found in most of the North Sea, the English Channel, Bristol Channel and Irish Sea, whereas *S. elegans* occurs round Ireland and Scotland *S. elegans* may be pushed up the Channel from the west, or south down the North Sea coast of England, by the influx of oceanic water from the Atlantic or the Arctic respectively. Oceanic species are *S maxima* (1) and *Eukrohnia hamata* (2) from the Arctic, and *S. serratodentata* (3) from the Atlantic.

neck region there is a fold of the body wall making a hood, this extends forward to cover and protect the head and to reduce water resistance during swimming

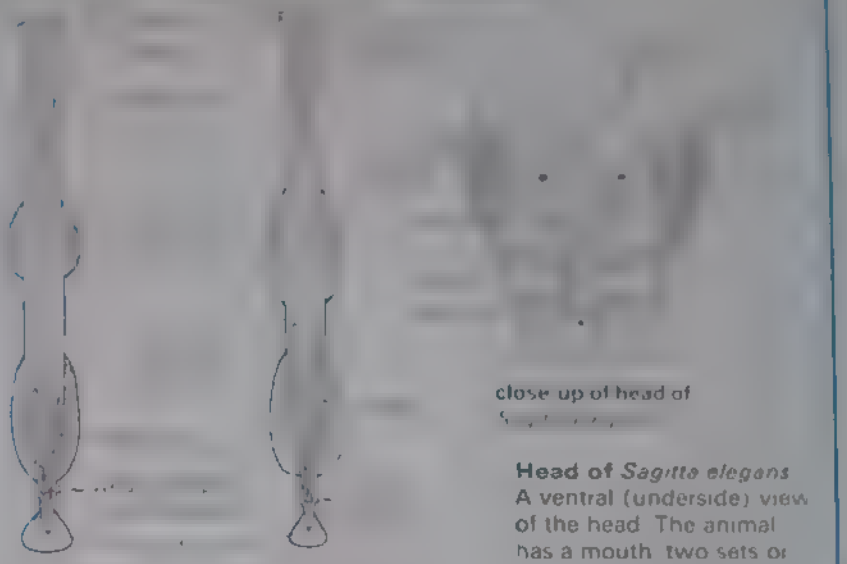
The elongated trunk makes up most of the body, and most arrow worms have one pair of horizontal lateral fins bordering trunk and tail However, the predominant British arrow worm genus, *Sagitta*, has two pairs of lateral fins the posterior pair overlapping on to the tail. Additionally, the tail leads to a further horizontal fin the caudal fin - at the back of the arrow worm

All the fins have ray-like supports analogous to those of fishes, but unlike fish fins, they are in the horizontal, not the vertical plane The head and trunk of the arrow worm are covered in fan-like arrays of sensory hairs in longitudinal rows. These detect waterborne vibrations just as the sense organs of the lateral line of a fish do, and assist the arrow worm to detect its prey

Seizing spines Arrow worms alternately float in the water with the fins as flotation devices and dart swiftly forwards with a violent up and down vibration of the tail Their transparency conceals them from predators such as fishes or seabirds, but also assists them to avoid detection by potential prey victims. Arrow worms are voracious carnivores, preying on other members of the zooplankton, especially copepod crustaceans detected by vibrations. The arrow worm hangs motionless until it suddenly darts forward in attack. The hood folds back, the long spines seize the prey and the rows of teeth pierce it. There is some evidence that arrow worms inject a toxin which immobilises the victim. Prey items include the larvae of fishes such as the herring, which may be as long as the arrow worm. They devour as much as the equivalent of 37% of their own weight each day.

Hermaphroditic habits Relatively little is known about the reproduction of arrow worms. Each worm is a hermaphrodite, and produces both eggs and sperm. The worm collects sperm in a packet for reciprocal transfer during cross-fertilisation. Fertilisation occurs inside the body of the worm, and the fertilised egg may be released to drift in the sea, or may be carried attached to the parent The eggs hatch as miniatures of the adult, with no intervening distinct larval form

Identifying arrow worms



close up of head of

Sagitta setosa
max length 2cm (¾in)

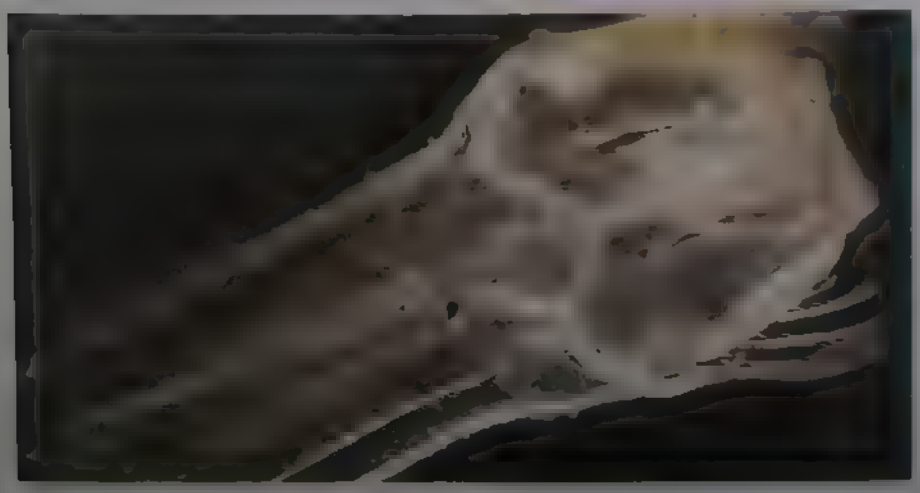
Sagitta setosa
Characteristics obvious gut without anterior gut pouches seminal vesicles wedge-shaped situated immediately behind the posterior lateral fin short ovaries transparent in formalin

Sagitta elegans
max length 2.5cm (1in)

Sagitta elegans
Characteristics anterior gut pouches present seminal vesicles are conical and set well back from the posterior lateral fins towards the tail body stiff and opaque or cloudy in formalin

Head of *Sagitta elegans*
A ventral (underside) view of the head The animal has a mouth two sets of short spines which act as 'teeth' and numerous long grasping spines for feeding The eyes are on the dorsal (top) side The hood is not drawn but you can see the line along which it folds back or forward. Gut pouches, a major recognition feature are clearly shown in the full-length drawing (left)

Below. A dorsal (top) view of the head of a *Sagitta* species of arrow worm. The eyes and grasping spines are particularly clear. Most plankton samples to be analysed have been pickled in formalin, and such preserved specimens of *Sagitta setosa* and *Sagitta elegans* can readily be distinguished: *S. setosa* usually remains transparent while *S. elegans* is cloudy or opaque In this example the general cloudiness of the head and neck suggest the species is *S. elegans*



Indicator species Many arrow worm species are found over wide tracts of ocean, especially in the tropics, although certain species are restricted to specific depth ranges or to coastal waters. In British waters, the two main species show very characteristic distributions and have been studied in detail for what they show about the movement of water masses in the sea. Both species belong to the genus *Sagitta* *Sagitta setosa* inhabits inshore coastal water or shallow seas close by (neritic waters), whereas *Sagitta elegans* is found in regions where coastal waters and ocean waters meet and mix.

The two species can therefore be used as indicator species to identify the precise locations of particular bodies of water of different origin. For example, the details of the distribution limits of *S. setosa* and *S. elegans* to the south of Plymouth varies from year to year as more or less oceanic water penetrates the Channel from the west.

Marine scientists thus avoid having to monitor complicated hydrographic data such as salinity and temperature profiles. When the movement of ocean currents causes a mixture to occur, the temporary presence of both indicator species provides information on the origin of the water.

STRANGFORD: AN IRISH SEA LOUGH

Strangford Lough, on the north-east coast of Northern Ireland, is a sea lough – an almost totally land-locked body of salt water which, because of its sheltered position, harbours a unique range of seabirds and marine animals.

At first sight from the roadside at Greyabbey or Kircubbin you might be mistaken into thinking that Strangford Lough is a large freshwater lake like many of the other Irish loughs. Looking out in every direction you are completely surrounded by land, with many hump-backed islands to the west, the Mourne Mountains in the distant south-west and Scrabo Hill with its conspicuous tower to the north. If you taste the water, however, you will find that it is salt, and many more islands will appear on the east side of the Lough as the tide falls. Strangford Lough is in fact a sea lough, connected to the Irish sea by a very narrow channel.

Bird life The islands provide breeding grounds for many birds in the summer, while the extensive intertidal mudflats to the north provide rich feeding grounds for visiting birds during the winter. Four species of tern breed on the islands in the summer sandwich, common, arctic and roseate–together with ringed plovers, oystercatchers, lapwings and snipe. The islands with more ground cover provide breeding grounds for mallard, shelduck and some eider ducks

The autumn sees a massive influx of birds from the north–waders, ducks and geese. The most important of these are the brent geese, and the 10-12,000 of these which arrive in Strangford represent 40% of the pale-bellied race of this species. They feed on the eel-grass beds which are exposed at low tide, and disperse later in the winter to other sites along the east coast of Ireland. Other winter visitors are thousands of ducks, predominantly wigeon, whooper swans and 30-40,000 waders – curlew, redshank, dunlin and many others.

Life on the sea-bed The Lough has a wide variety of sublittoral communities, mainly due to the range of water movement within it. This results in a range of sediments from boulders, through gravel where the tidal currents are strong, to the finest mud in areas of little water movement. The water is never very clear, due to suspended mud in the winter and a rich growth of plankton in the summer. As a result seaweeds grow mostly in relatively shallow water – few living below 10m (about

Above: Whooper swans roosting at sunset on Strangford Lough. The present-day character of this Lough is largely a result of the last Ice Age, when the area lay beneath a slow-moving ice sheet. The ice transported rocks and soil into the area and then retreated, leaving behind characteristic rounded hills or drumlins. The Irish Sea then inundated the area, turning some of the drumlins into islands and submerging others completely

40ft). In deeper water the sea-bed is dominated by animals feeding on the abundant plankton and detritus suspended in the water

The sea-bed in the Narrows area consists mostly of boulders with some areas of bedrock. The strong tidal streams provide abundant food for the animals that can survive in these currents, and the entire sea-bed is covered with a dense carpet of hydroids, deadmen's fingers, sponges and mussels. Some active animals live in crevices among the boulders, including edible crabs, velvet swimming crabs, butterfish and Yarrell's blennies

In the southern part of the Lough itself, where the water movement is not quite so strong, the sea-bed is covered with a dense carpet of brittle stars living on coarse gravel and boulders. Other animals often live among the brittle stars, for instance the sea anemone *Urticina eques* and the great scallop *Pecten maximus*

The horse mussel beds Where the water is quieter, among the islands and along the edges of the main channel, there are often dense beds of horse mussels (*Modiolus modiolus*) These are very rich areas as the mussels lie on the surface of the mud in clumps, cemented together with byssus threads secreted by the mussels themselves. The shells of the mussels provide firm attachment for many other filter-feeding animals, including the variegated scallop *Chlamys varia* and a range of sponges, hydroids and sea squirts. Many

Strangford Lough is connected to the Irish Sea by a channel 8km (5 miles) long and less than 1km (½ mile) wide. The open part of the Lough is about 19km (12 miles) long from north to south and 5-6km (3-4 miles) wide. Water rushes through the channel, known as the Narrows, at speeds of up to 7 knots with the tide

Above left: A sea anemone, *Tealia eques*, surrounded by a gathering of common brittle stars (*Ophiothrix fragilis*) on the bottom of Strangford Lough

Below: A queen scallop (*Chlamys operularis*) with brittle stars. The pinkish body in the bottom left of the picture is a species of starfish called sun star (*Crossaster papposus*). In Strangford Lough the sun star comes close to its southern limit, for it is primarily a creature of colder northern waters

worms and small crustaceans find shelter within the mussel clumps and the whole community can be very diverse, with 50 species living together in 1sq m (10sq ft) of sea-bed. This community is the one most vulnerable to dredging as it is entirely based on the mussel clumps; if these are removed nothing but mud remains

Large areas of pure mud do exist, probably where conditions are not quite right for the mussels. This mud is very soft and sticky, and is the home of the Dublin Bay prawn or scampi (*Nephrops norvegicus*). These prawns, which are really more like small lobsters, live in tunnels which they construct in the mud The usual burrow is V-shaped, sometimes with an additional side-entrance, and may be shared by a fish, Fries' goby (*Lesuerigobius friesii*). Few other animals live on this mud, but the anemone *Sagartiogeton laceratus* is quite characteristic of this habitat, attaching itself to pieces of shell buried in the mud.

Management of the Lough As a result of several gifts and purchases of land, the National Trust has now acquired control of all the foreshore and several areas of land adjoining the Lough, together with two important country houses, Castleward and Mountstewart. This means that the Trust can largely control development and sporting activities on the Lough, which it does through its Strangford Lough Wildlife Scheme. A committee representing the various interests

in the Lough meets regularly, and is able to balance the interests of conservation, wildfowling and sport to the benefit of all who use it.

Fishing pressures on the Lough are minimal at present. There is a large oyster-culture industry developing in the north-eastern part, and one boat fishing for scampi with pots. Neither of these activities is detrimental to the Lough at their present level. Occasionally large fleets of boats dredge for great scallops and queen scallops, usually when bad weather in the Irish Sea forces them to seek sheltered waters. This type of fishing is very harmful, especially to the horse mussel beds which take many years to re-establish themselves if they are damaged. Wildfowling on the Lough is strictly controlled by the wildfowlers themselves, who realise that conservation of the Lough and the bird populations is important to the future of their sport. The birds must be allowed to breed in peace and quiet so that their numbers can be maintained at a reasonably high level. There are clearly defined seasons for shooting and the quotas are carefully regulated so that no species is allowed to decline and disappear

A recent threat to the well-being of the Lough was a proposal to build a tidal barrage across the entrance to generate electricity. It was calculated that such a barrage could supply 10% of Northern Ireland's electricity from tidal power. However the proposal would have resulted in a drastic reduction of the tidal range within the Lough, with the lower half of the present intertidal area being permanently submerged. This reduction of the feeding grounds for the wintering bird populations would probably have been the main drawback of the scheme from a conservationist point of view. Luckily the proposal has now been abandoned, but with new technology and increasing costs of energy it must remain an attractive proposal from an engineering viewpoint. It is to be hoped that Strangford Lough's unique fauna and flora will be given proper consideration and protection in the future

Top left Strangford Lough is a paradise for birds especially wildfowl and seabirds Four species of tern breed on the Lough's islands in summer, including this arctic tern

Above: The hydroid *Clava* here shown on *Fucus*, is to be seen in the Lough's somewhat murky waters

Left Some large animals can be found in the Lough Record-sized tope and skate have been caught in the past and there is a large population of common seals which haul out on to rocks and islands in the Narrows Family groups of killer whales have been seen, and porpoises (shown here) are common visitors

DISPERSAL OF FRESHWATER LIFE

Virtually absent during the last Ice Age, fishes and other freshwater animals have since spread throughout Britain and Ireland. Their surprising mobility results from the help of natural forces, and some species are assisted on their way by man.

The effects of the series of ice ages which covered the British Isles to a greater or less extent until some 12,000 years ago were fundamental in dictating the distribution of freshwater animals. This can be seen in a number of animal groups, of which fishes are well documented. It seems that following the last glaciation there were no purely freshwater fishes in Scotland, Ireland, and most of northern and western England. Southern England escaped being covered with ice, although the climate was extremely cold and it is doubtful whether many kinds of fish survived, if any at all did

After the ice retreated, fishes are believed to have migrated through the fresh waters of the

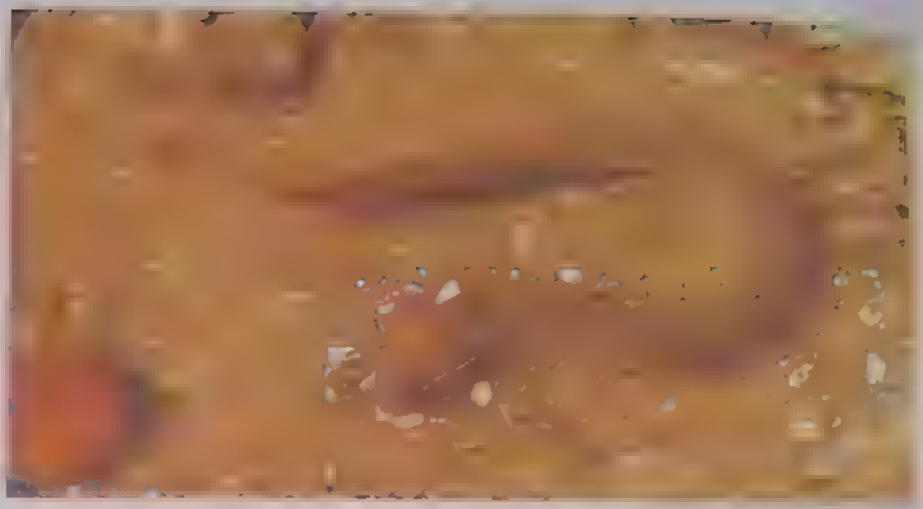
Above: A river in Devon, flooded in winter. This is an example of one way for freshwater species to be distributed within a river's catchment area. It is rare, however, for floods to cross into another river system.

Right: In eastern rivers of Britain the tench is a native fish. It has long ago been introduced from these rivers into those of other parts of Britain, and to Ireland. Being tenacious of life, it spread successfully.

landmass that joined eastern England to continental Europe. Even today the numbers of species of fishes, and freshwater invertebrates, is greater in the eastern flowing rivers of England (the Yorkshire Derwent, Ouse, Trent, Great Ouse, and even the Thames) than it is in the western flowing rivers

Migratory fishes Even so, many kinds of fish are found throughout the British Isles Some such as the trout, salmon, eel and stickleback are fishes which, thanks to their physiological adaptations, can live in sea water as well as in fresh water. These species can thus distribute themselves via the sea into previously uninhabited rivers and then colonize them. Not surprisingly, these fishes are the most widely distributed species of all

Confined to fresh water Other fishes, such as the pike and perch, cannot survive in sea water, and yet they are almost equally widely distributed, being found throughout England and in much of Scotland, Wales and Ireland. In many of these areas they cannot be native



Below: The black bullhead, an American species, was introduced here mainly to stock aquaria and ponds Subsequently the species has been released in the wild and there are now many local populations

How have they arrived in such distant areas? The same question has to be asked for the many invertebrates which are purely aquatic, and yet have colonized fresh waters in areas which were covered by ice and thus uninhabitable to them only a few thousand years ago

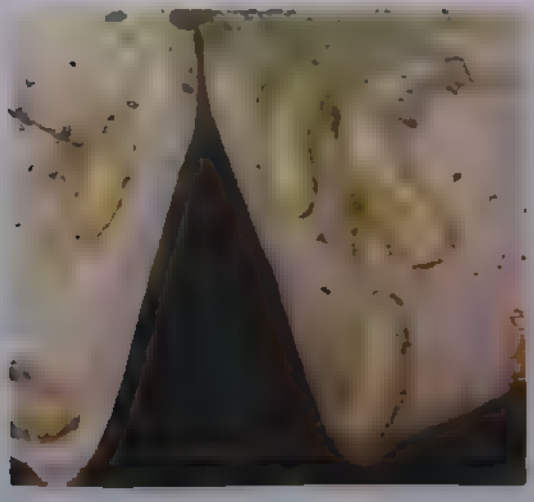
Natural forces Floods have certainly played a part in dispersing animals within a river valley. This is the way many lakes or gravel pits in the flood plains of rivers have received some of their animal life, especially the larger animals such as fishes which, when young and relatively poor swimmers, are swept along by floods across water meadows into newly created still waters.

A second natural dispersal route in flood plains is through the underlying strata. These are often gravel, which is surprisingly porous and offers the opportunity for small mobile invertebrates, such as some crustaceans, to travel underground between a river and nearby streams.

However, both these opportunities for dispersal are all within a river system, not from one system to another. Natural connections between separate river systems are rare.

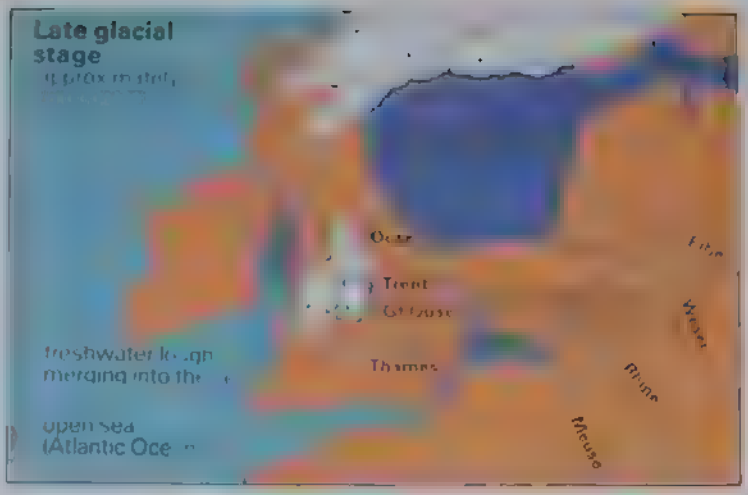
A popular fallacy A frequently suggested means of dispersal for fishes is that their eggs can be carried on the feet or feathers of wading birds and ducks. Although it seems to be a widely held belief, it is not a possible solution. Fish eggs have only a thin outer covering and they would very quickly dry out, causing the embryo to die, if exposed to air. Although it might be possible to carry eggs for a few yards, it would be quite impossible for them to be carried, for example, across the Irish Sea. Moreover, their way of breeding is such that the carriage of a few eggs from one stretch of water to another is unlikely to result in an established population. Mortality among fish larvae and fry is very great, often more than 90%, and ultimately at least two fishes of opposite sex would have to survive and meet to breed.

However, terrestrial animals and birds may sometimes aid the distribution of isolated specimens of fishes, and possibly establish invertebrates in new waters. Recently the author found a live fish in a puddle close to an



Left. Egg capsules of the pond snail *Limnaea stagnalis*. The snail lays its eggs on leaves of aquatic or waterside plants. Man assists in the dispersal of the pond snail by constantly moving aquatic plants from one place to another, for example when making ponds or clearing overgrown waterways. These capsules contain thousands of eggs, which means that only one batch need be transferred to a new water for a whole new breeding population to be established

Left: The freshwater eel is an example of our migratory fishes. Eels are able to live in sea water; this one is in fact in sea water. Since they migrate from the sea up our rivers they can colonize rivers that were previously uninhabited by eels. The eel has a particularly wide distribution for, alone among our native fishes, it travels overland albeit on dark, rainy nights, to reach otherwise inaccessible lakes and even ponds.

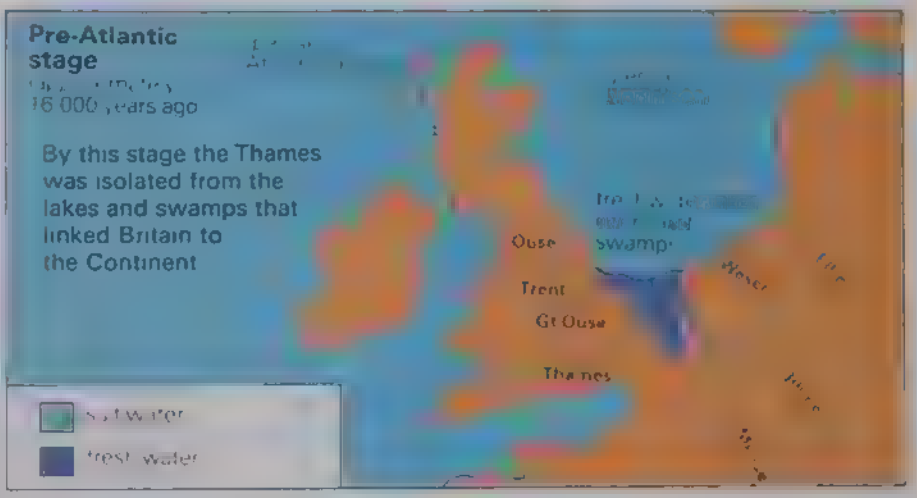


Left and below: During the last ice age, dry land joined Britain to the Continent, and Ireland had a narrow land bridge to Britain. As the ice melted the seas filled. At first the North Sea was a lake of fresh water (see left), and fishes and other freshwater animals crossed from Europe into Britain. As the ice cap melted (see below) the North Sea became salt, but a land bridge still joined Britain to the Continent.
Note: opinions on the dates vary considerably. Other theories abound!

Essex lake in which herons fish, and from the wound on its side there was no doubt that it had been stabbed by a heron which had then been unable to swallow it. The fish was a North American catfish, *Ictalurus melas*, a population of which lives in the nearby lake; possibly its broad head and large pectoral spines were too much for the heron to swallow. Remarkably, it had survived capture and the transport over a few yards to the puddle, but such an incident is hardly an efficient means of dispersal.

Invertebrates, on the other hand, may occasionally be dispersed by birds. A Norwegian scientist, trying to establish whether waders and ducks could distribute freshwater shrimps (*Gammarus* spp.) from lake to lake, found that on very rare occasions these animals were trapped in the leg feathers of the bird. The author has twice found pea-shell cockles (*Pisidium* spp.) fastened to birds; one was on the web of the foot of a mallard, and the other on the lower feathers of a coot.

The human factor All these means of possible dispersal so far discussed are unlikely to have resulted in very distant or significant increases in animal distribution in fresh water. Probably the case of the North American catfish offers a clue to the most potent factor in animal dispersal—man. There are many examples of lakes of varying sizes that have populations of these introduced fishes. In each case, someone must have released them: they are occasionally available in aquarium shops.



Below: Originally, bleak in Britain were confined to the eastern rivers, which they had colonized from the Continent (see maps). They have since spread through canals and by being used as live bait.

There seems to be no explanation for the occurrence of perch and pike in Scotland and Ireland other than that man had deliberately introduced them there, and from lake to lake within those countries. In carrying fishes around the British Isles in order to release them in new waters, man has also carried plants which contain invertebrates such as freshwater shrimps, and molluscs of various kinds, and this has aided their dispersal.

New colonist Man's elaborate system of canals has also presented freshwater animals with an opportunity to disperse themselves. The equally elaborate system of drinking water supply—aqueducts, reservoirs, pumping stations, filter beds and domestic taps—is another means of dispersal. The little North American amphipod crustacean, *Crangonyx pseudogracilis*, which looks like our native freshwater shrimp except that it is smaller and crawls upright, not on its side, has spread in England by this means. How it first arrived in England remains a mystery.

HERBS IN THE ROSE FAMILY

The rose family is one of the largest families of flowering plants with almost a hundred native British species. About half are herbaceous and include such favourites as cinquefoil, meadowsweet and wild strawberry, though not roses themselves.

The rose family, known to scientists as the Rosaceae, is a large group of about 2000 species with members found throughout the temperate regions of the world. The family includes both woody and herbaceous members and many are of great economic importance: apple, pear and cherry trees, raspberry and blackberry all belong to the family. The hundred or so species native to Britain are divided almost equally between woody members and herbaceous ones.

Family features Whether woody or herbaceous, family members are easily recognisable by a combination of features. The flowers consist (in almost all cases) of five petals and five sepals arranged symmetrically around a central cluster of stamens and [illegible]. The leaves are usually arranged alternately along the stems and bear stipules–small scale-like appendages at the base of the leaf stalk. The only other family such a plant could be thought a member of is the saxifrage family, but the two families are easily separated by the fact that members of the saxifrage family lack stipules.

Another feature often found in plants of the rose family is the presence of an extra set of sepals outside the usual five sepals on the flower. Since the sepals are known as the calyx the extra set is usually referred to as the epicalyx. This feature can be seen on wild strawberry, the cinquefoils and wood and water avens.

The arrangement of the flowers varies between different species. On silverweed, for example, the flowers are comparatively large and borne on individual stalks, whereas on dropwort the flowers are tiny and clustered together on short stalks. Each cluster of the second type of flower is known as a compound inflorescence. Lady's mantle, great burnet and salad burnet all have compound inflorescences.

Variable fruits The fruits of plants in the rose family are just as variable as the flowers, ranging from the fleshy, orange-red drupes of cloudberry and the swollen red receptacles of wild strawberry to the dry cluster of fruits of wood and water avens. From a distance the fruits of wood and water avens look like dandelion clocks, yet there is a great difference between the two. In avens each 'clock' consists of a collection of seeds that have all developed from one flower. Dandelion clocks, however, consist of a collection of fruits, each of which has developed from a separate flower (the flowering head of a dandelion is a

Above: Wild strawberry (*Fragaria vesca*) in flower and fruit. Apart from its distinctive fruits, this plant is very similar to another member of the rose family, the appropriately named barren strawberry (*Potentilla sterilis*) which has fruits consisting of hard yellowish nutlets and leaves that are bluish-green.

Right: One of the commonest members of the family is meadowsweet (*Filipendula ulmaria*) with its heads of fragrant cream flowers

Above. Alpine lady's mant e (*Alchemilla alpina*) can be distinguished from the ordinary lady's mantle (*A vulgaris*) by its palmately (hand-shaped) compound leaves, the latter having palmately lobed leaves. They also occupy quite different habitats, the alpine species occurring on mountains while lady's mantle is a owland plant

Left. Fragrant agrimony (*Agrimonia odorata*) bears spikes of yellow flowers similar to those of common agrimony (*A. eupatoria*) though in the former they have a lemon scent

Below: Silverweed (*Potentilla anserina*), one of the commonest members of this large genus, which includes cinquefoils

Below right: Marsh cinquefoil (*Potentilla palustris*) has attractive reddish-purple flowers quite different from the yellow flowers of most species in the genus *Potentilla*

compound inflorescence not a single flower)

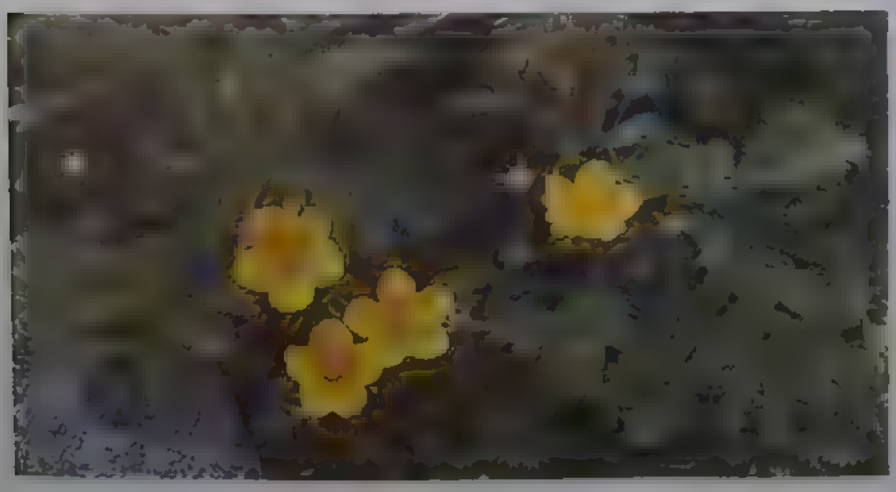
Mountain species There are about 45 species of the rose family native to Britain, most being annual or perennial, though a few are biennial. With so many members growing in this country it is not surprising that they occupy a wide range of habitats

High up in the mountains of the north and west can be found two of our less common members, alpine lady's mantle and mountain sibbaldia, the latter being the rarer. Both grow in short turf and among rocks and crevices on our more exposed mountain tops. They are well adapted to a cold windy habitat, having such features as a low-growing habit and the possession of hairs on the leaves and stems

Further down the mountain slopes, you may occasionally see alpine cinquefoil, which gains protection from the weather by growing in rock crevices or hidden under boulders This is a particularly attractive species with large golden-yellow flowers that often have orange spots at the bases of the petals

Moors and fens As well as being mountainous, north and west Britain is also characterised by many bogs and moors. One of the more typical species of such areas is cloudberry, the only herbaceous member of the blackberry genus, *Rubus*. Its large white flowers are followed by red bramble-like fruits which turn orange when ripe. Although they are considered edible, the fruits have a floury texture and tend to be rather bitter. A more familiar moorland species is common tormentil, which grows on light, acid soils on heaths, bogs and moors–even mountain tops where it tends to adopt a creeping habit of growth. The flowers are a deep lemon-yellow and are borne in loose clusters

In wetter areas of marshes and fens you



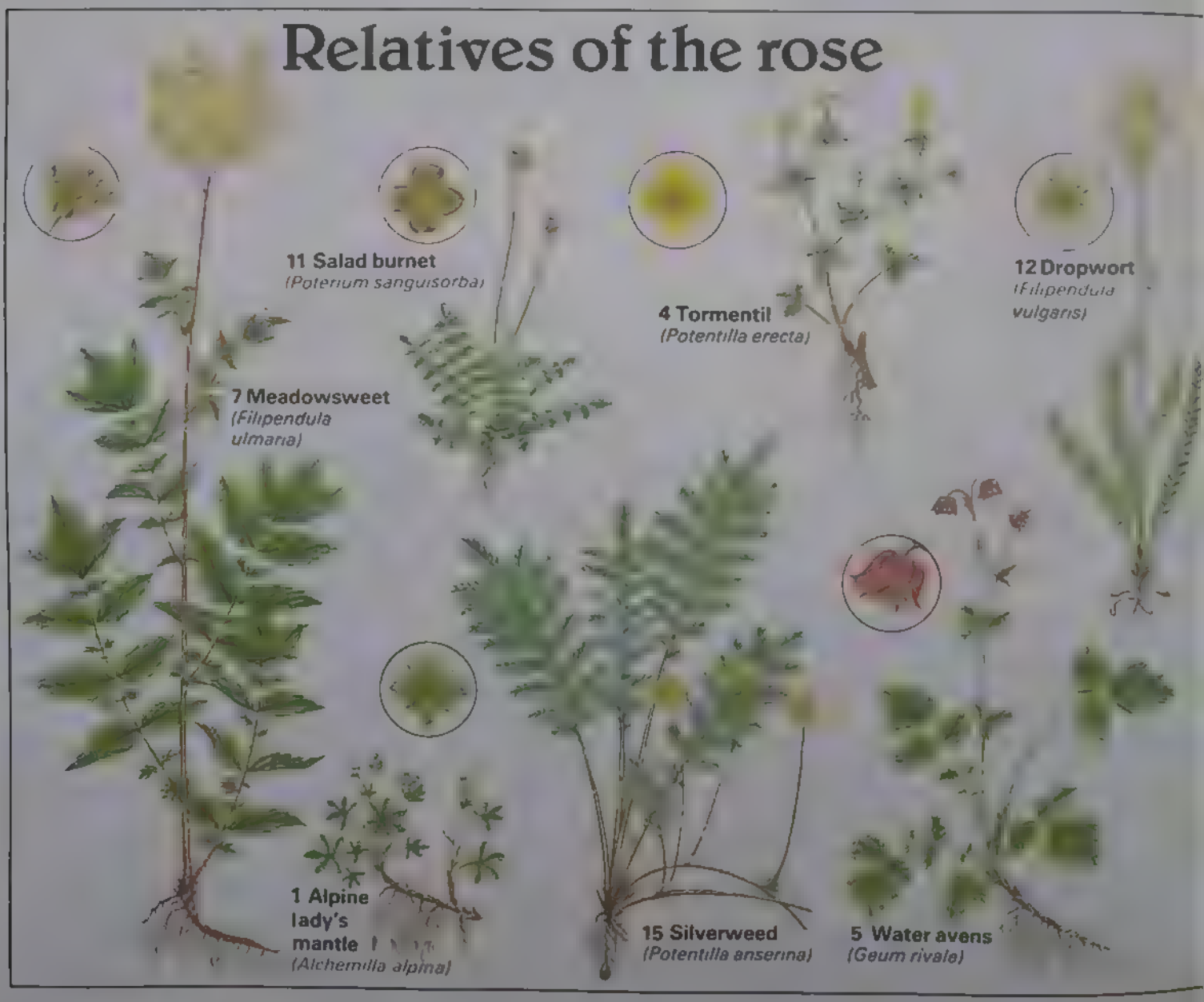
Above: More common in the north of the country than the south, water avens (*Geum rivale*) prefers damp shaded sites. The hairy purple calyx and epicalyx enclose five orange-pink petals.

may also find marsh cinquefoil with distinctive deep reddish-purple flowers and compound leaves, the leaflets being borne in a similar arrangement to that of a horse chestnut tree.

One of the most widespread herbaceous members of the rose family is meadowsweet which, as well as occurring in swamps, marshes and fens, also inhabits water meadows, stream sides and wet woods, though it does not tolerate acid peat conditions. Perhaps the most outstanding feature of these plants is their large heads of creamy white flowers which emit an unmistakable heavy perfume.

Pairs of plants Another member of the family with a preference for wetter habitats is water avens, which bears pale pink flowers on dark red stems from May to September. It is most common in the damp woods of north-west England. If you live in the southern half of the country you are much more likely to see the closely related wood avens, which has buttercup-yellow flowers–so the two species are not likely to be confused.

Two species which are often confused, however, are the barren strawberry and the wild strawberry. They are not closely related to each other, the former belonging to the genus *Potentilla* and the latter to *Fragaria*, yet both bear small white flowers, similar leaves



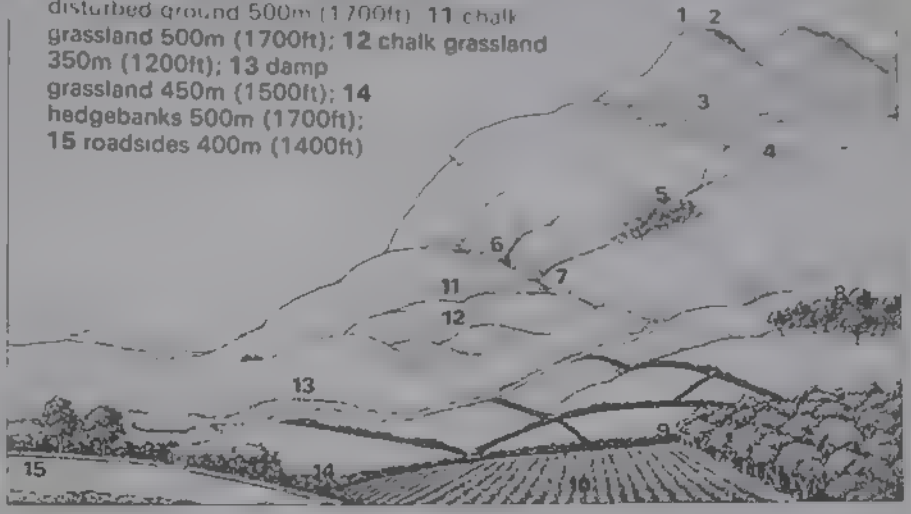
and share the same habitat: open woodland and dry grassland. However, the difference becomes obvious soon after flowering, for the barren strawberry lacks the characteristic red fruit of the wild strawberry.

Hedgerows, woods and downs Other dwellers in hedgerows and woodland include lady's mantle and common agrimony. The former is similar to alpine lady's mantle, except that it occurs in different habitats and has different shaped leaves. Common agrimony, with its tall upright spikes of pale yellow flowers, is one of the more untypical members of the rose family. Another unusual member is the parsley piert, which is one of the few annuals in the family. It is a small plant with greenish flowers found in disturbed ground.

Open chalk grassland is the best place to see downland meadowsweet, more commonly known as dropwort, and salad burnet. Dropwort has the same characteristically foamy heads of flowers as common meadowsweet, though they lack any fragrance, and the two plants also occupy quite different habitats. Salad burnet flowers lack petals.

Rose relatives—where to look

Typical habitats for the plants illustrated below, with the maximum heights above sea level at which they occur in Britain. **1** mountain tops 1200m (4000ft); **2** mountain tops 1200m (4000ft); **3** moors 1150m (3800ft); **4** heaths 1050m (3500ft); **5** damp woods 1000m (3200ft); **6** fens 900m (3000ft); **7 stream sides 900m (3000ft). 8 open woods 750m (2400ft). 9** wood margins 500m (1700ft); **10** disturbed ground 500m (1700ft); **11** chalk grassland 500m (1700ft); **12** chalk grassland 350m (1200ft); **13** damp grassland 450m (1500ft); **14** hedgebanks 500m (1700ft); **15** roadsides 400m (1400ft)



Some of the more common or distinctive members of the rose family native to Britain. The family can be recognised by their leaves, which are borne alternately along the stem and have stipules at their bases, and by their flowers. In most members of the family these consist of five petals and five sepals arranged regularly around a central cluster of stamens and style. The flowers are mostly borne singly, but in some cases they are in compound inflorescences.

14 Common agrimony *(Agrimonia eupatoria)*

2 Mountain sibbaldia *(Sibbaldia procumbens)*

8 Wild strawberry *(Fragaria vesca)*

3 Cloudberry *(Rubus chamaemorus)*

6 Marsh cinquefoil *(Potentilla palustris)*

10 Parsley piert *(Aphanes arvensis)*

9 Wood avens *(Geum urbanum)*

13 Great burnet *(Sanguisorba officinalis)*

WHALE BEHAVIOUR: SOME REASONS WHY

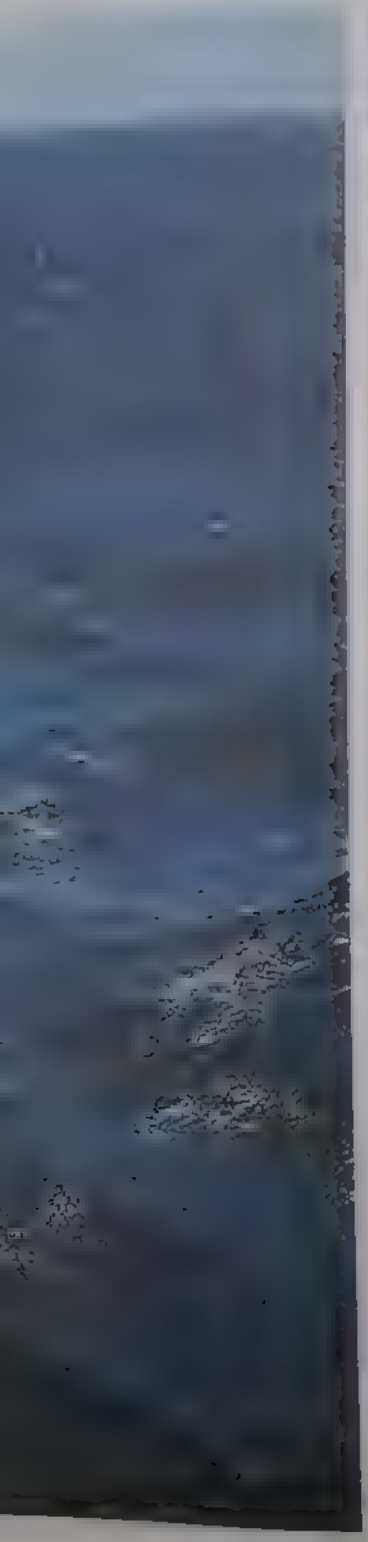
Our knowledge of the behaviour of whales and dolphins is still fragmentary, mainly because they spend so much time under water. However, recent studies in the wild and in captivity have helped to shed some light on their mysterious lives

Many people are familiar with dolphins as performing creatures in zoos, performing tricks or learning complicated routines. Their engaging behaviour and seemingly friendly facial expressions have won them millions of admirers of many and, together with their intelligence and the tendency to help each other when in distress, have encouraged by many as the human equivalents the pinnacle of social sophistication and intelligence. This view of dolphins and their larger relatives, whales, has doubtless helped to place them in a special position and strengthened the outrage felt by many at their slaughter.

Whales and dolphins (cetaceans) live in a different environment from man, one which

Right: The white-beaked dolphin breaching, probably to communicate information to other members of the herd or to help in the capture of its prey by concentrating the shoal and then panicking the fish at the sea surface

Below: These pilot whales were photographed from a nearby boat. Pilot whales seem unconcerned by man and his boats even though in some parts of the Atlantic a boat can mean whale hunters



requires different senses. Except close to the sea surface, little light is present; on the other hand, sound is propagated over much greater distances through water, particularly at low frequencies. It is therefore not unreasonable for the behaviour of a whale to be moulded rather differently from that of terrestrial mammals. For this reason it is not always helpful to speak of cetacean intelligence in the same terms as we might use for humans.

Indeed, man has difficulties enough in deciding what he means by his own intelligence. We impose our standards to evaluate whether an individual shows high intelligence, and these are dictated by the differences in our culture, which may also determine our abilities to learn various tasks. For this reason it is often difficult to compare intelligence between groups, and to compare species, particularly those as different as whales and man, probably has even less meaning.

Living together Many whales and dolphins are gregarious, at least for part of their lives, occurring in herds which in the smaller dolphins may number a thousand or more individuals. Even some of the large baleen whales, which at first sight appear to range singly or in pairs, may form part of a much larger aggregation, spaced out over a great expanse of ocean, perhaps 2500sq km (1000sq miles) or more, and in contact with one another by their low frequency calls.

This gregarious habit is probably important in their quest for food since most marine prey, whether fish or plankton (and probably squid also, though their ecology is poorly known), is widely dispersed in groups. Concentrations occur where nutrients are brought to the surface, either by the meeting of water currents of different temperatures, or ridges and valleys in the ocean floor, headlands or islands. Studies of bottle-nosed dolphins have shown that a resident herd may have a home range of about 85sq km (33sq miles) and larger species such as pilot and killer whales almost certainly have ranges much greater still

It is probably most efficient for whales and dolphins to space out while foraging for food, and if they are in communication with one another an individual or group can alert the others when they have located food, though the extent to which they do this is little known Some species, such as the common and white-beaked dolphins, forage in herds usually numbering 5-15 individuals. They form aggregations often exceeding 100 animals which may co-operate in herding fish. We are still unclear as to the precise nature of these feeding activities and extent of co-operation between individuals, but we can probably assume that the gregarious habit increases the opportunities for successful location and capture of prey.

The highly social habit of many whales and dolphins has a number of consequences for the development of complex social behaviour and quite sophisticated systems of communication. Although no whale or dolphin can be regarded as having a language in the sense that we know it, some species have been shown to use a wide variety of vocalisations. Studies of humpback whales have shown that members of one population share a number of phrases for communication in sub-tropical coastal waters during their migrations. Each year the song of the humpback changes a little, so that it must be that members learn the song of that year while in the breeding grounds.

Above: The Risso's dolphin. This species is polygynous, that is the male may possess a harem of females. Males may compete for such groups of females by sparring matches and this probably accounts for many of the scars to be seen on the flanks of individuals. This dolphin is a younger animal

Opposite page (bottom): A killer whale surfaces briefly, showing its conspicuous white patch that extends backwards from just behind the eye. Another recognition feature is its upright dorsal fin situated midway along its body. It is the only whale habitually to prey on other warm-blooded animals

Just as birds may have their own song dialects between one geographical region and another, so do whales. Killer whales, for example, have quite distinct dialects depending on whether they come from British Columbia, Baja California or the Bay of Fundy, north-eastern United States. As yet we have no evidence that the large rorqual whales –blue, fin, Sei and Bryde's– have quite the same variety of sounds as humpbacks and smaller killer whales. However, their low-frequency vocalisations serve the important function of long-distance communications.

A question of size Herd size is probably determined by the abundance and distribution of prey. The large baleen whales require great concentrations of plankton which probably only rarely occur in sufficient abundance to support a big herd. This may be a reason why the smaller dolphins occur in big herds, but blue and fin whales, for example, rarely occur in herds exceeding six individuals. However, over-hunting by man has almost certainly also depleted the populations, so the natural numbers may once have been greater.

Groups may afford greater protection from predators. If you take a boat up to a herd of pilot whales, the older males almost invariably position themselves between the females and young and the potential predator. In this way, they are behaving like large ungulates such as wildebeest in the presence of a lion or cheetah. Killer whales and sharks probably represent the only threat to whales and dolphins besides man.

It is probable that young whales and dolphins require a long period of learning before they can readily find their patchily distributed food and capture agile prey such as squid and fish. This may be why in most species, maturity is not reached for a number of years and there may be mixed schools of breeding adults, immatures, and juveniles of the year. Female bottle-nosed dolphins, for example, have frequently been seen with their calves for as long as 15 months so that a strong social bond exists between mother and calf and must remain long after weaning.

Some species such as the killer whale, and Risso's dolphin, are polygynous, a male holding a harem of adult females, though the herd may include some young animals. The killer whale also may form bachelor herds of young males which, as they mature, will start to seek a harem of females of their own. Other species, such as the common dolphin, appear to have a much more open herd structure. Males tend to be promiscuous, mating with a number of females but forming few long term attachments.

Herd structure Individuals may move between herds over a period of months or a year, though some may remain together from year to year, and in the short term such herds can be quite stable. It is possible that although there is much interchange of individuals between herds, these function merely as aggregations of a large herd that is much more stable in its overall composition. A number of dolphin species show segregation among herds: female bottle-nosed dolphins and their calves, for example, often travel in groups that include only a few, if any, adult males. When adult males are present, they tend to be with

Whales getting together

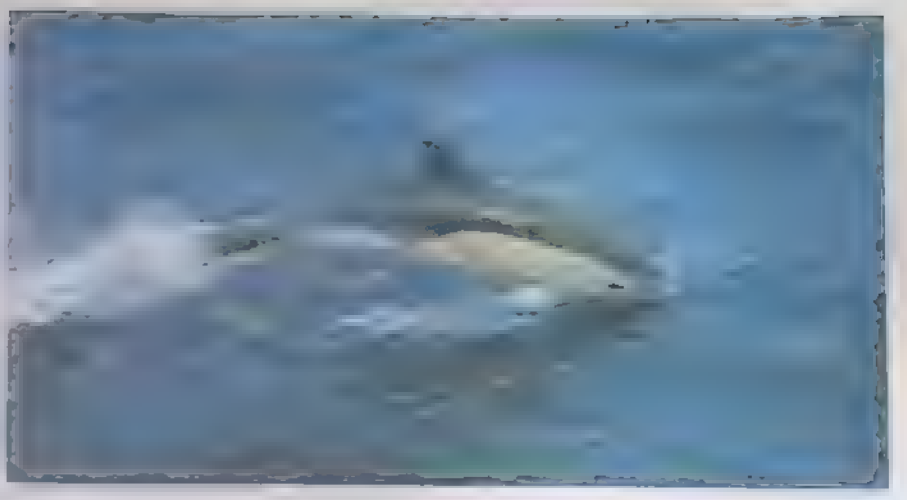
It is quite common for more than one species of cetacean to associate together when foraging for food or making long-distance movements. Particularly common is the association between pilot whales and bottle-nosed dolphins (shown here). Presumably at least one of the species benefits. In this case it may be that the bottle-nosed dolphin, normally an inshore species of shallow waters, bays and estuaries, takes advantage of the navigational powers of the more pelagic pilot whale during movements far out to sea. There is still much more to learn of these associations.

groups of females without calves. Sub-adult males tend to form distinct bachelor herds Similar segregation by age and sex has been found in pilot whales and common dolphins, and may, as our knowledge of different species increases prove to be the normal pattern.

Many dolphin species, both in captivity and in the wild, have been shown to have dominance hierarchies. Bottle-nosed and common dolphins, for example, show this hierarchical behaviour, with large males being dominant (and more aggressive) over smaller males, males dominant over females, and mature animals dominant over sub-adults However, in dolphins individuals low down in the hierarchy may nevertheless mate with as many females as a high-ranking individual Those species with a stable herd composition tend to have the more structured herds. A few years ago, in the Outer Hebrides, a large bull killer whale was seen to capture a grey seal and having killed it, to move aside until the rest of the herd had fed upon it

It is probably the long period for maturation and the relatively large amount of time available for social interaction that has allowed the development of complex social signals and a rich behavioural repertoire in many dolphin species. Nevertheless, it would be wrong to describe whales and dolphins as having an intelligence comparable with man or any of the higher primates. Whatever measure is used - brain size, presence of a language or the ability to be innovative cetaceans generally score no more highly than other social mammals such as dogs, domesticated or wild. Furthermore, they are not necessarily the placid animals of popular belief The scars upon the flanks and around the head of Risso's or bottle-nosed dolphins testify to the fights that may take place, presumably between males when competing for females

The polygynous sperm whale may use its massive head (proportionately much bigger than the female's) for butting against other males when attempting to maintain or take control of a herd of females



Above Common dolphins may frequently be seen breaching or porpoising like white beaked dolphins they somersault and break the surface to and once more on their bellies sides or even their backs Apart from breathing fresh air and looking for food, they may behave in this way to search for visual clues such as rocks headlands or even other dolphins, as well as to communicate information to each other

BIRD TERRITORIES

Several kinds of territory and territorial behaviour can be observed in the birds of Britain and Ireland, forming an exciting aspect of bird study.

A territory is a defended area: in discussing territories, the use of the word defence implies that someone will take your territory from you if you do not adequately defend it Experiments with many species of birds have shown that there is indeed constant pressure on territories: when researchers captured and removed the territory holders, new occupants of the same species quickly replaced them, often in hours rather than days

Social behaviour in birds contrasts with territoriality, for sociality involves flocking, colonial breeding or the common ownership or use of a particular area. However, sociality and territoriality can be combined in the same species in various ways. For example, in the crow, pairs of breeding birds occupy territories, while non-breeding crows live in a flock nearby, often in an area that is unsuitable for breeding due to a shortage of nest sites. Should a crow territory fall vacant, it is quickly occupied by one of the members of the flock.

Territorial song With such pressure on territory holders, it is essential that they devote as much time as possible to securing their hold on their own plots. However, in many situations it is not possible for a territory holder to see all of his boundary from one vantage point, and he cannot therefore be on hand to see and drive away any marauder Furthermore, it would take up far too much of his time and energy if he attempted to patrol the boundary with the constancy needed to keep out intruders. In fact, such constant vigilance is rendered unnecessary by a form of communication that works over long distances–song

Song has several functions, of which mate attraction is perhaps the most obvious But in an experiment where male great tits were

Above A scene on the Grassholm gannetry, Wales These are non-breeding birds that do not hold territories but occupy a small area on the edge of the colony known as a 'club'. They include adults who have failed to secure a territory as well as immature birds such as the mottled sub-adult at the centre

Below: The nesting colony at Grassholm. The nest sites are densely packed and vigorously defended, making a regular pattern

removed, their territories were kept free of intruders for some time by playing tape recordings of great tit song over loudspeakers.

In other birds, the posture of the territory owner may be sufficient to signal to a potential settler that an area is already occupied. For example, starlings adopt a characteristic posture while singing, with the wings held slightly away from the body, the feathers of the crown and throat puffed out and the tail directed downwards, giving a 'hunch-backed' appearance. Starlings often adopt this posture while not singing, but while perched on an exposed song post within easy view of any bird looking for a territory

At first sight, it appears strange that a bird looking for a place to settle should be deterred by a bird that is simply singing or displaying When this system fails, however, and the intruder does try to stake a claim, the home-owner almost always wins the ensuing contests, whether these consist of threatening displays or physical combat.

It is not entirely clear why a male is usually victorious on his own territory. It may be because of his superior knowledge of the terrain. Whatever the advantage, the presence of a bird advertising that he is the landowner is often sufficient indication to an intruder that if he does attempt to settle, he will use up valuable time and energy in a conflict that he is unlikely to win

Kinds of territory The kind of territory with which most people are familiar is that of the garden blackbird. In this type, a breeding pair defends a plot of land of around one fifth of a hectare ($\frac{1}{2}$ acre) against other blackbirds Within this territory, the pair feed and build their nest

Above Starlings going to roost at sunset The birds live in flocks all year round, sometimes joining together in vast communities The area over which the flock ranges in search of food is known as the home range Since the birds nest in holes, which are naturally some distance apart, their breeding colonies have to be spread out over a large area For this reason, starling colonies are not as obvious to view as those of rooks or seabirds

Left Part of a rookery, in tall trees by a motorway

Below: The territorial song of the robin can be heard clearly all round its territory. This spares it a lot of the work of patrolling its boundary

Breeding pairs of robins also vigorously defend a territory in the breeding season but, unlike blackbirds, robins become aggressively territorial again in the autumn. Now, however, males and females defend separate territories in which each individual feeds, and these autumn territories are smaller than those held by pairs in the spring

Starlings and rooks, on the other hand, are far more social than robins and blackbirds. They stay in flocks during the breeding season, just as they flock at other times of year. It is readily apparent, from looking at a rookery, that rooks are social while nesting. The same applies to starlings, although their requirement for holes as nest sites leads to a somewhat greater dispersal of nests and their coloniality is less readily visible. Sociality has its limits, however, and around the nest

both species drive off intruders. In these species, the territory is therefore restricted to a small area around the nest. The birds are content to share their feeding grounds, and do not even defend them against birds of their own species from neighbouring colonies

The area over which the breeding rooks and starlings travel in search of food is thus not a defended territory, and is known as a home range. A tiny nesting territory and an even larger home range, sometimes extending 100km (60 miles) from the nest, is typical of many seabirds, such as the gannet, kittiwake and guillemot. In the case of the guillemot, the defended area is limited to a small length of cliff ledge around the egg or chick, so that each narrow ledge looks from a distance like a line of black and white birds

Territories with no nests In the breeding territories mentioned so far, the nest site has been a vital component. While this is the case for most British birds, there are exceptions When shelduck return to their breeding grounds from the moulting areas to which they migrate in autumn, they spend much of the winter in flocks. In late winter, however, they form pairs. These pairs are territorial and defend feeding sites on the muddy banks of estuaries

The ownership of a territory is, as in other species, essential for breeding: but shelduck do not breed on their territory. They breed under cover of thick vegetation, or use rabbit burrows in dunes and sea walls, some distance from the feeding territory. During incubation, the feeding territory remains the centre of activity for the non-incubating male, and his mate leaves the nest about four times each day to feed on the territory.

In the case of ruff and black grouse, a small and vigorously defended territory is used neither for nesting nor for feeding, but only for display. Such display territories, or leks, are used by those males that have been able to obtain one in complex ritualised displays which become more and more intense when females are around. The females are attracted to the display territories by the activity of the males, and visit the territories to mate. The lekking area is generally on an open piece of ground, and while 20 or more males hold territories there, the females are attracted to some males more than others. As a result most copulations are achieved by relatively few of the males Presumably this polygamous mating system selects the 'best quality' males to father the next generation

Pied wagtails in winter Like the robin in autumn, some pied wagtails occupy individual territories in winter. These are simply feeding territories, and the occupation of one of these depends both on the individual's status and on how much food is available Where food is predictably plentiful, high-ranking individual birds hold territories. A juvenile pied wagtail may be allowed to feed within the territory, and when it does it helps in territorial defence. Where food supplies are more transient or scarce, pied wagtails feed in flocks. Should the 'dependable' food supply fail, as when a river bank freezes, then the territory-holders vacate their plots, and join the flocks. The pied wagtail thus alternates between the two forms of territoriality

Above. This scene on a great tit territory illustrates two display postures at the same time The male (on top of the stump) is displaying to his own mate, but in many species a similar posture is used in defence of a territory Vanquished males adopt postures rather like the submission posture of his mate, with bowed head and trailing wings

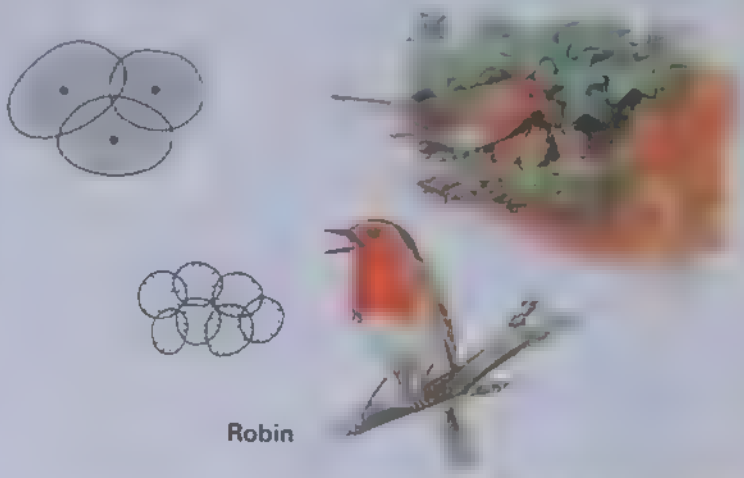
Below. Robins defend territories in winter as well as spring, as the two photographs clearly show On the left, a territory holder confronts a stuffed robin that has been placed on his 'patch'. On the right, he triumphs over the intruder, of whom little can be seen but the upturned wooden base

Types of territory

Birds are either solitary or communal nesters. Breeding territories vary from relatively large (eg blackbird) to very small (eg gannet). Similarly birds feed either alone or in flocks. Some solitary feeders (eg shelduck) defend feeding territories, while flocking birds use undefended areas. Pied wagtails are unusual because in winter they feed either in defended territories or in flocks, depending on conditions. The most unusual type is the lek territory (eg ruff) this is used for neither nesting nor feeding, but purely for display and mating

- nest site
- defended breeding territory
- defended feeding territory
- defended display territory
- home range (non-defended area used for feeding)

Blackbird

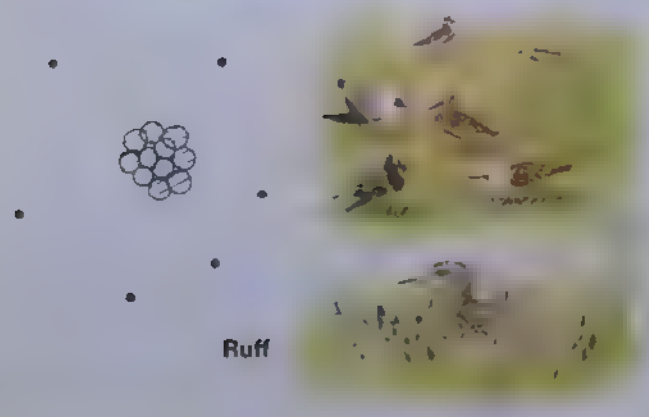


Robin

Starling

Rook

Shelduck

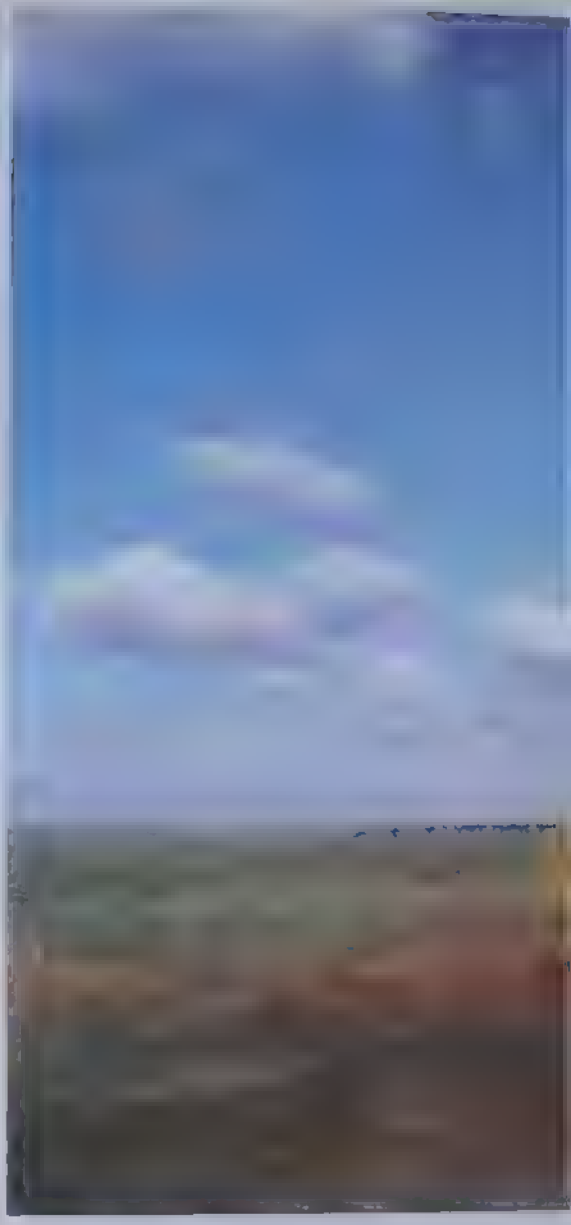


Ruff

Pied wagtail in winter

THE BRECKLAND OF EAST ANGLIA

Like so many parts of lowland Britain, the Breckland is not a natural landscape but man-made created by forest clearance, land enclosure, sheep and rabbit grazing and forestry planting. Today it is particularly interesting for its special flora.



Below: A rabbit peering out of its burrow, which has been dug in sandy soil. One of the most important factors in the formation and maintenance of the Breckland was the introduction of the rabbit in the 12th century by the Normans for fur and food. The numbers of rabbits increased very rapidly in the 1400s, when managed warrens were an important form of land use, but they became feral (wild) only at the end of the 18th century. In recent years myxomatosis has taken a heavy toll and since 1956 very few rabbits have survived. The consequent decline in grazing by rabbits (and also by sheep, whose numbers are greatly reduced as well) has altered the Breckland landscape.

The word 'breck' was first used in 1674 by John Ray. It applied to an unenclosed area of arable land, which may have been in cultivation for a number of years and out of cultivation for short or long periods. The term 'Breckland' was coined by W G Clarke only as recently as 1894.

Today the Breckland is a mosaic of countryside, chiefly characterised by open, grassy heaths with scattered gorse bushes and some bracken, separated by rows of pine trees or blocks of conifer plantations. The soils are sands and chalky glacial tills overlying chalk with local gravels and loess. The pH values vary considerably and these variations are reflected in the different vegetation types.

The creation of Breckland The open nature of the Breckland was first created when Neolithic man cleared the mixed oak forest as he colonized the area and worked the flint mines, such as Grimes Graves (now open to the public). In the 12th century the common arable land of the parish was one compact unenclosed area, divided into three shifts for winter cereal, spring cereal and a fallow. Later, in the Middle Ages, barley was grown extensively. There were permanent grass areas, the more important of which were located on the margin of the fen and the arable shift. Flocks of sheep grazed the heathland and provided the essential fertilisers.

In the 18th century pines were planted as shelter belts for game and later on as protection against wind blow. Sand blows occurred frequently in the past, as is illustrated by the story of one landowner who, when asked in which county his property was situated said, 'Sometimes in Norfolk and sometimes in Suffolk -it blows backwards and forwards'. The last major sand blow was in 1668, when the village of Stanton Downham was buried.

During the Napoleonic period there was a great agricultural revival when chalk and marl digging became prominent (marl being a type of clay soil rich in lime). These materials helped to maintain the soil structure and fertility. After 1820 there was a collapse of farming and game became more important.

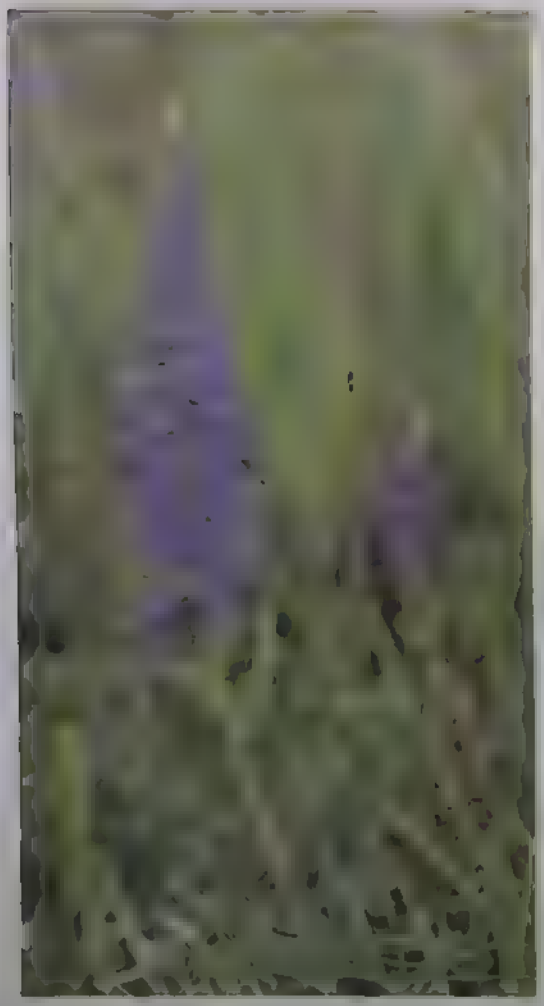
Above Typical Breckland scenery—Thetford Warren in Norfolk The land is fairly flat with gently rising hills up to 60m (200ft) above sea level, and with many tumuli The area has the lowest rainfall of any inland area in Britain—less than 600mm (24in) annually The summer temperatures tend to be high, with a relatively high percentage of sunshine Snow never lies for long, while frost may occur in any month of the year

Blocks of conifers were then planted as game cover, but it was not until the 1920s that the Forestry Commission began to plant up large areas

Animal life The largest animals you may encounter in the Breckland are deer There are four species, three of which are native—red (which occur mainly in the Thetford Forest), roe and fallow. The muntjac was introduced into Britain during the last century and has now spread throughout southern England The Forestry Commission monitors the native species annually in certain study areas and culls are carried out.

The red squirrel occurs in some of the Scots pine plantations, but is declining. Hares are often seen running across the grassy heaths and their forms, scraped in the sandy soil, provide pitfalls for the unwary. The rabbit, though, must be considered the most influential Breckland animal. From being abundant in centuries past, its numbers have recently been drastically reduced by myxomatosis. The sandy heaths provide ideal territories for common lizards and grass snakes, but the

Right: The sand cat's-tail is one of several coastal species of plants that occur on the sandy soils found in parts of the Breckland



Above: A view of Wangford Warren. This, a Suffolk Trust for Nature Conservation reserve, has one of the best examples of lichen heath in Breckland

Left: Breckland is famous for its speedwell species. This is the spiked speedwell, now restricted to just four sites and protected by law

Below: The woodlark, though declining nationally, is still found in the area. Here it is at its nest, with not yet fledged chicks

adder is the most characteristic reptile

The Breck contains many nationally rare insects associated with the dry heaths and the wetter fens, which occur in the lower-lying ground and by the few rivers. Disturbed ground, a result of arable farming and animal activity, supports an ephemeral plant association which yields a rich community of moths, beetles and bugs, as well as providing nectar for many bees, wasps and flies. Sandy tracks are used by many solitary wasp species as nesting sites–species such as *Episyron rufipes* and *Pompilus cinerus*, both spider-hunting wasps, or *Cerceris arenaria*, which provisions its nest with weevils, and *Ammophila sabulosa*, which preys on caterpillars for the same

purpose. The open, sandy heaths are similar to coastal dunes, so that insects normally found at coastal sites occur here inland at places such as Wangford Warren, a Suffolk Trust reserve

One of the typical sights in the Breckland is the dipping flight of the green woodpecker, accompanied by a flash of bright green and a cheerful 'cackle'. The glimpse of white on the open ground betrays the presence of the wheatear, but the stone curlew is so well camouflaged against the sandy, stony patches that it is extremely difficult to observe. This species is well protected by wardens and has continued to thrive over the past few years, unlike the red-backed shrike, which was once more widespread and is now virtually lost from Breckland. A species which has increased is the nightjar. The scattered bushes on the heaths and cleared areas within the coniferous forests are particularly suitable habitats for it

Breckland plants Most of the notable species are those of the 'Continental' element that is species that prefer warm, dry summers, and can tolerate harsh, cold winters Many of them are quite small, usually less than 5cm (2in) high, and botanists are often seen on their hands and knees peering diligently for such plants as the annual speedwells–the Breckland speedwell, the fingered speedwell and the spring speedwell These are all found on arable or disturbed ground where the soil has a high lime content Although the plants may be small in stature, they do have attractive names, for example the perennial knawel, the Spanish catchfly, shepherd's cress and suffocated clover.

Changes in the landscape Before Neolithic man, much of the area was afforested, mainly with deciduous trees. Now it is the conifer plantations which dominate large tracts. Since 1947, when a Suffolk farmer first used summer irrigation methods, more open heath has been cultivated, and various developments in techniques for spreading lime, fertilisers and pesticides have also meant an increase in arable farming. The demand for sand and gravel continues for the building of houses and roads, and the town of Thetford illustrates the amount of urban development and industrial expansion that have occurred in recent years. Together with this is the need for more leisure areas, and several heaths are now in use as golf courses. Because of the flatness of the land, it is an ideal place for aerodromes and the once extensive area of heath that was Lakenheath Warren is now dissected by the USAF base at Lakenheath. Other major events in recent times have been the striking reduction in the numbers of sheep and rabbits

But these changes do not necessarily mean a drastic reduction in areas of ecological interest. The Breckland was, and continues to be, fashioned by the hand of man. It is a dynamic system and species of interest are

Above. Knotted pearlwort is a plant of damp sandy places and peaty areas. This low growing perennial, though not a rare species, is nevertheless attractive

Right Spanish catchfly–one of the Breckland 'specialities This species is not found anywhere else in the British Isles

Below A heathland soil profile. This soil, which is found over much of Breckland, is sandy and poor the nutrients quickly leaching through the thin band of topsoil

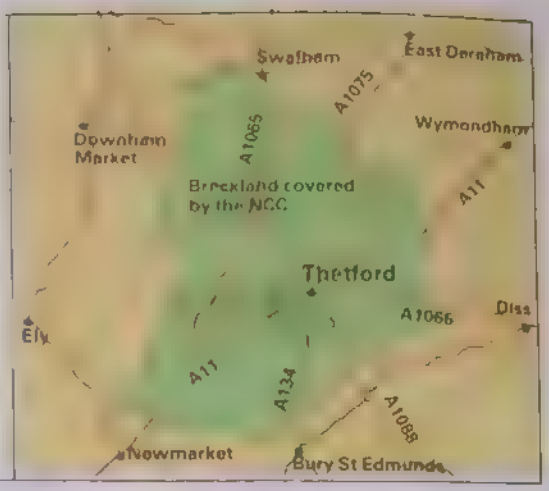
found in the disturbed habitats as well as in the relatively stable ones. Airfields encompass large areas of land, some of which are built upon, but also the need for a clear view means that large tracts are left intact and are continuously mown, a form of management which is a substitute for sheep or rabbit grazing, and so the low-growing plants survive within their boundaries. Golf courses also provide patches of short turf, the 'rough', together with screening patches of bushes, giving a similar diversity to that occurring on the original heaths The Stanford Training Area north of Thetford is one of the largest remaining areas of Breckland Access is strictly limited so that destructive fires do not occur and the tank activity provides a certain amount of the disturbed ground which is an essential part of the pattern that is the Breckland

There is, too, the possibility of discovering something new. The military orchid was found in an old Breckland chalk pit in 1954–a site at least 80 miles north of any previously known locality for the species

Within the last few decades the Nature Conservancy Council, the Suffolk Trust and the Norfolk Naturalists' Trust have acquired or have the management agreements on many of the remaining fragments of heathland in the region Breckland continues to be a shifting pattern of land use influenced by man, as it has been since Neolithic times

Where is the Breckland?

The Breckland is an area of land of approximately 600sq km (230sq miles) in East Anglia and the town of Thetford is considered to be its centre There are three administrative counties included within its boundaries–Suffolk Norfolk and a small part of Cambridgeshire. (This map shows the approximate boundary



Right Insects occur in great numbers in the Breckland The small copper butterfly seen here on ragwort–is a typical species of sandy heaths its caterpillars feed on sheep s sorre

Below: Not all of Breckland is heathy–some parts have been planted by the Forestry Commission This is a view of woodland in Thetford Warren in Norfolk

RARE AND VAGRANT BIRDS FROM ASIA

The astonishing power of birds to fly huge distances is brought home dramatically on the relatively few occasions when the process of migration goes wrong. Each year, a few wandering individuals from Asia's migratory bird population, having lost their way or been blown astray by storms, arrive in Britain.

Above: One problem with rare birds is deciding whether an individual is a wild one or an escape from a zoo or collection. The red-breasted goose (shown here) is native in Arctic Siberia, but several British sightings have been traced to wildfowl collections. True vagrants tend to occur in flocks of white fronted geese

Below A sharp tailed sandpiper from east Siberia.

The migration journey of birds is a time of many hazards, especially for small species. Migrating birds are at the mercy of the weather until they reach their destination. Heavy rain may quickly drench them and force them to the ground or into the sea; and strong winds may blow them a thousand miles or more off course. Clouds may blot out the sun or stars, by which most birds navigate, causing them to fly for several days or nights on end in the wrong direction. It is these migration hazards that are usually responsible for the appearance in Britain of species which normally breed and winter on the other side of the world, in Asia.

Rarities and vagrants Technically, a vagrant or accidental is defined in Britain as a bird that has been recorded less than 20 times. A

number of Asian species occur slightly more frequently than this in Britain and these, while still the object of great fascination among birdwatchers, cannot strictly be described as vagrants: rarities is a better word. Considerable ornithological skill and knowledge are sometimes needed to spot and identify birds of either category from Asia

Where they come from By definition, Asia begins at the Urals a long mountain range running from north to south and marking the eastern limit of Europe, over 4000km (2500 miles) east of Britain. Its northern parts are occupied almost entirely by Siberia, which stretches for some 6500km (4000 miles) eastwards to the Bering Straits. At its eastern end, Siberia's neighbours are China, Mongolia, Korea, Japan and Alaska

Only a handful of bird species from Asia migrate purposely to or through the British Isles: the main examples are knot, white-fronted geese and curlew sandpipers. The great majority of Asia's migratory birds spend the breeding season in Siberia or its eastern neighbour countries, and winter in southern Asia, Australasia or Africa. Nevertheless, wind-blown or disorientated individuals regularly arrive here, thousands of miles off course and with no hope of reaching their normal wintering grounds or of ever rejoining the rest of their species. In general, most of these Asian birds occur in spring or autumn, during periods of strong easterly winds. They tend to occur on the east coast of Britain

Asian pipits Pipits are among our commonest Asian visitors. In Britain, rock, tree and meadow pipits are common breeders, and in Europe, tawny and red-throated pipits also occur. Three other species breed only in Asia. Richard's, Pechora and olive-backed (or Indian tree) pipits, and of these Richard's pipits occur in Britain most often, over one hundred being seen some autumns. They are large, boldly streaked birds, reminiscent of skylarks in stance, colour and habits, but their loud, explosive call 'schreep' is quite unmistakable

Left A booted warbler, photographed on St Mary's in the Scilly Isles in October It is a member of a group of warbler species known as Hippolais warblers The bird is native only in Asia and occurs in Britain very rarely Especially for small birds like this one can never be sure exactly how many vagrants arrive in Britain For every one seen and identified there might be 10 or 100 lurking in the bushes

Below A young lesser golden plover. This species breeds in both Siberia and North America, so may arrive in Britain from both east and west

Below: Richard's pipit frequently arrives in Britain accidentally, and in some autumns over 100 birds are sighted here. The bird bears a close resemblance to its European relatives

Asian warblers A number of Asian warblers are also recorded in Britain, and these provide some of the greatest identification problems Attention to detail is always essential, and copious notes made on the spot are invaluable if a positive identification is to be made Yellow-browed warblers, looking like a cross between a firecrest and a willow warbler, can easily be overlooked. These birds are tiny, only 10cm (4in) long, with two pale wing bars and a long creamy stripe over the eye. Much less commonly seen, and perhaps the most surprising visitor from Asia, is Pallas's warbler (or Pallas's leaf warbler). This species breeds from southern central Siberia east to the Sea of Okhotsk (north of Japan), yet at least one or two occur in Britain each October or November. It is only 9cm (3½in) long, and weighs only 5g (⅛oz).

Both these warblers–and the dusky warbler, another Asian species–are related to the willow warbler and chiffchaff, but other warbler groups also have Asian representatives. The lanceolated warbler, a close relative of the grasshopper warbler, is very rarely seen in this country. It is exceptionally skulking,

Sample breeding ranges

Eight birds from Asia

Above: The map gives four examples of breeding ranges of Asia's migratory bird species. The Pechora pipit is an example from the tundra bordering the Arctic. The lanceolated warbler's range stretches east as far as the Sea of Okhotsk and south as far as Japan. The sociable plover breeds on the steppes of central Asia. The citrine wagtail has a very wide distribution, ranging from the Arctic coasts to central Asia, and from west of the Urals to China. Also illustrated are eight of the birds themselves, including the four referred to in the map. The citrine wagtail is shown in immature autumn plumage, the typical appearance of vagrant birds arriving in Britain. In the other seven species, male, female and immature plumages are all closely similar

and in the treeless terrain of Fair Isle, where it has been found most often, it runs like a mouse along the furrows of a field, rather than flying in full view.

Of the Hippolais warblers (the group including icterine and melodious warblers), the booted warbler is a truly Asian example. Like the previous species, there have only been a handful of records in Britain, all in autumn. The paddyfield warbler, a relative of the reed warbler, is yet another example.

Vagrant thrushes There are several species of thrush which breed beyond the Urals, and these, too, are occasionally recorded here. The Siberian, eyebrowed and dusky thrushes have only been recorded a few times each, but the black-throated thrush is now into double figures. This beautiful bird is the size of the song thrush but with grey upperparts, white underparts and black face, throat and breast. Even more frequent, with over 30 records, is White's thrush, which is even larger than our mistle thrush and characterised by golden-brown plumage with black crescent-shaped markings and striking black and white bands beneath the wings.

Non-qualifiers Some Asiatic bird species that occur as vagrants in Britain do not automatically qualify as Asian vagrants, simply because they breed in Eastern Europe as well as Asia. Of the waders, the sociable plover–a lapwing-like bird–is a typical example of this. In contrast, the sharp-tailed sandpiper–rather more like a dunlin–breeds only in north-east Siberia, 8000km (5000 miles) away, yet over a dozen have been identified here. Others, like the lesser golden plover, also breed in North America.

ROE DEER: A SUCCESS STORY

Roe deer are one of Britain's most successful mammal species, as well as one of the most beautiful. The reasons for their spread and wide distribution lie in their adaptability to make use of a wide range of different habitats.

Above A roe deer buck shedding its winter coat. Roe have a very short tail, usually hidden in the fur.

Left. A fawn lies hidden in the undergrowth shortly after its birth. Fawns freeze if they are threatened

Right: Roe occur in a wide range of woodland habitats as well as along woodland edges and in fields. In Scotland they are found in heather moorland, and they survive well in wetland areas too.

So many species of animals seem to be threatened by habitat loss, that it is cheering to discover that in fact many are well able to adapt to modern conditions, and in fact profit from them: the starling and collared dove are just two examples Some live so successfully at our expense that we call them pests. Rats and mice come into this category, but so, for many people, does the charming and delicate roe deer. The key to the success of all these creatures is their ability to take advantage of new opportunities for feeding. Such animals usually have a lack of specialisation, which allows them to exploit quite a variety of new habitats

Not only in this country, but over the whole of Europe, deer of all species are increasing, while other quarry species, such as the partridge, the blackcock and even the wild pheasant, are in decline. Sweden now has so many elk that they are a serious problem. In Scotland and parts of England there is a super-abundance of roe, which can be a real headache to foresters in particular because of damage to sapling trees.

Old inhabitants Roe have been present here since the early Pleistocene, about 550,000 years ago. During three successive glacial periods ecological belts were shifted southwards, but between them were long intervals of warmer weather when the vegetation zones moved northwards, with their associated fauna. Together with such species as the bear, the hyena and the giant deer, roe have been recorded in all these interglacials when savannah conditions prevailed, and they probably persisted well into tundra phases as well. Their ability to survive in a sub-arctic climate is demonstrated today in Sweden, where roe are even now penetrating far to the north.

Since the end of the last glaciation, the story of the roe in this country has probably been one of continuous occupation, and certainly since the land bridge with Europe was broken about 8000 years ago. In the last 2-3000 years they have not only had to contend with the varying climate, but their natural predators, such as the lynx and the wolf, have been replaced by man.

During historic times the growth of our human population has to some extent profited the roe. It took advantage of the second growth that followed the clearance of primary woodland but throughout the Middle Ages it came under increased pressure. Hunting methods became more sophisticated, and while roe deer were protected like other Royal quarry under the Forest Law until 1323, they were then demoted to Beasts of Warren, on the grounds that they drove away other deer. After that, their numbers steadily declined. As early as Stuart times roe were already scarce in southern England, and were virtually extinct there by the 18th century. At the same time they retreated into the most remote parts of Scotland.

Twentieth century roe Following various introductions during the 19th century in different parts of the country (see map), sufficient colonies of roe deer existed by the time of the First World War to profit from the changing times, and the seeds of expansion were sown. Today roe are found wherever there is sufficient woodland or even hedges and small thickets to provide them with cover and browse, from the Channel coast to beyond the Thames, and from Lancashire and Derbyshire to Caithness. The original release at Thetford now forms an additional population which occupies a large part of East Anglia

There is no doubt that emergency timber felling in both wars provided ideal cover and food in the untended jungles which resulted The countryside was emptied of the game keepers and farm workers who in the past had been quick enough to see and snare or shoot the roe which nobody valued sufficiently to preserve, so roe populations expanded During and after the Second World War efforts were made to control numbers by communal deer drives in which a large number of beaters and guns were involved. Many of the latter had very little experience of the technique of using a shotgun, let alone its extremely short range when used against deer. While many deer were killed (and more wounded) by these and other inhumane means, the main effect of driving was to disperse the deer and increase the speed of colonization.

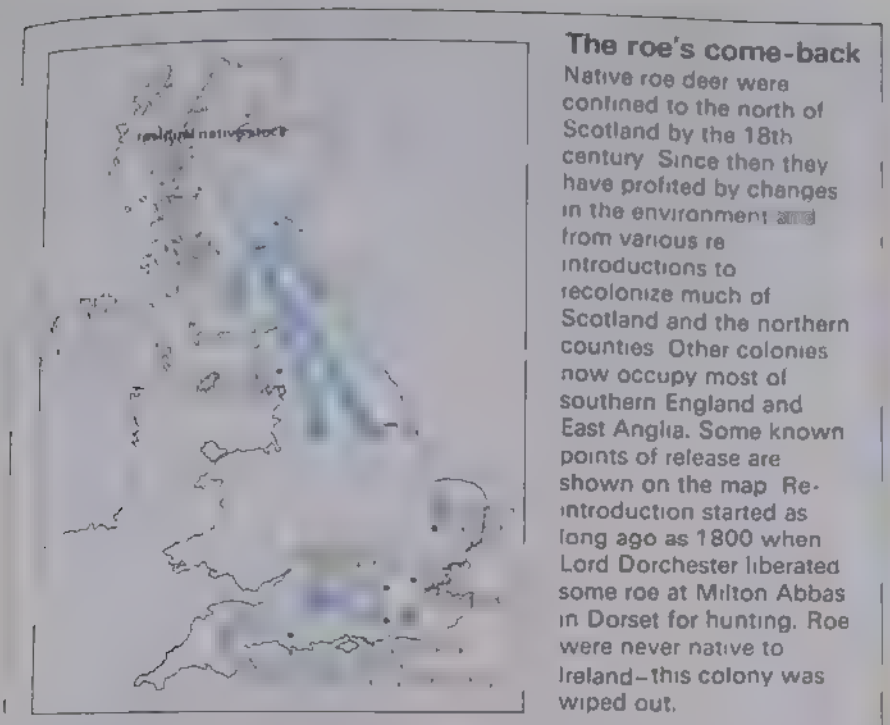
Post-war afforestation which has increased our woodland area by something approaching 800,000 hectares, created a vast new habitat which was quickly and fully colonized by this small deer which makes itself thoroughly at home as much in thick forests of spruce monoculture as among the rose-beds and wooded parks of suburbia. This success springs not only from a catholic taste in woody browse, but from adaptability in behaviour that ensures survival in an enormous diversity of habitats

Survival tactics Roe do not behave in the same way on the heather moors of the Scottish Highlands as on the outskirts of London, just as their food is totally different. The low ground buck is a heavy beast, weighing 5kg (11lb) or more than his mountain cousin There are probably abundant coppice shoots of oak and hazel to supplement his favourite bramble, and even in late winter when browse may run low, small parties of deer are seen emerging on to autumn-sown cereals to eat not only the nutritious growing tips of the crop but also couch grass and other weeds. In contrast, hill roe subsist on heather, willow and rowan leaves and buds, and -to the forester's fury-the leading shoots of newly planted conifers. Though its weight may be less, the hill roe is scarcely less healthy

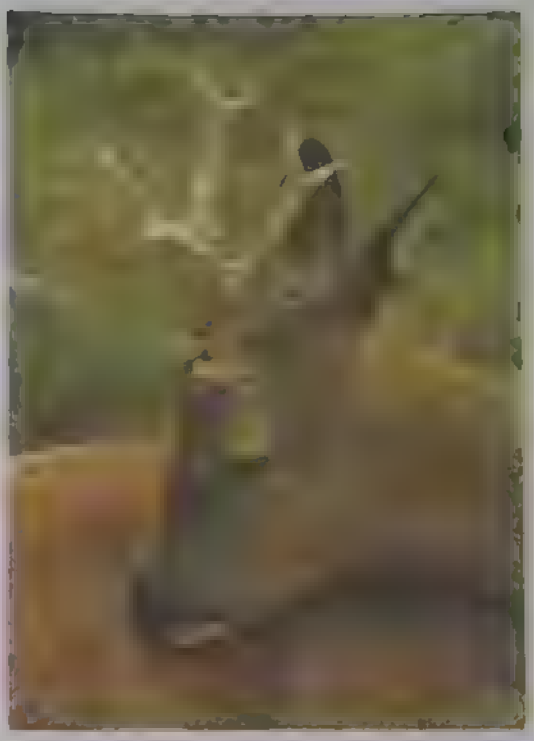
The roe relies on finely tuned senses, nose, ears and eyes, to avoid detection rather than on speed to escape capture, but the way those senses are employed in different surroundings shows the basis of the species' success Anyone used to watching roe deer in the thickly populated, over-used woods of Surrey for example, will be astonished to see how the same species reacts to human presence on the northern heather moors. Suburban roe are so

Above Hill roe live on heather, willow, rowan buds and leaves, as well as the young shoots of conifers

Below A female suckling her fawn. Twins are very common and triplets are born occasionally



The roe's come-back
Native roe deer were confined to the north of Scotland by the 18th century. Since then they have profited by changes in the environment and from various re introductions to recolonize much of Scotland and the northern counties. Other colonies now occupy most of southern England and East Anglia. Some known points of release are shown on the map. Re-introduction started as long ago as 1800 when Lord Dorchester liberated some roe at Milton Abbas in Dorset for hunting. Roe were never native to Ireland–this colony was wiped out.



used to the close proximity of humans, most of whom mean them no harm, that they tend to stay motionless, relying on the fact that few people actually look for deer; or if they are detected, they slip a metre or two into the nearest cover. Obviously scent and hearing are paramount, coupled with an innate ability to distinguish between meaningless or purposeful human behaviour.

Roe of open country Hill roe, many of whom can scarcely ever see a man, are on the contrary extremely shy. They are watchful, in the same way as red deer; the slightest movement is detected at a distance and will probably be followed by flight, eyesight being used in a way which is foreign to suburban roe. These open country deer have also been quick to make full use of forestry drains in the newly planted areas, to improve their already well-developed ability to disappear. A buck may be seen quietly feeding in a grassy flat perhaps, where the only cover is provided by young conifers. He gives no sign of alarm as he walks behind a tree hardly big enough to hide him. You wait, expecting him to reappear and as the minutes lengthen you realise that somehow he has slipped away. When you go up to investigate, the tell-tale footprints show how he has slipped into a nearby furrow to make his escape. Other roe, assuming themselves to be unobserved, have been seen sneaking away in so crouched a manner that their bellies brush the ground.

Above right: Roe deer bucks have comparatively short antlers which, unusually, have pearling in contrast to other species in the British Isles.

Below: A roe deer fawn in summer. Its black and white spotted coat ensures that it is well camouflaged in the early months of its life. By autumn it develops a reddish brown coat which changes to greyish brown in winter. At that stage it is often hard to tell parents and offspring apart.

One of the other problems which foresters have to face is that while roe in scattered woodland eject their young to wander away and find new homes, deer in the new conifer forests show the reverse: yearlings are driven deep into the plantations, from which they emerge in unexpected numbers to feast on newly planted trees.

Although roe regulate their own numbers by emigration and starvation, the density they will tolerate may produce unacceptably high damage to farm and forest crops, not to speak of gardens. Nor do we find the thought of large numbers of deer dying by starvation or disease a comfortable idea. In the absence of large predators, such as the wolf, we have a duty to provide what control is neccessary and to do it humanely. Fifty roe does produce about 85 fawns every year. Even if half of these die naturally before they are a year old, this still leaves 40 or more surplus if numbers are to be kept level. If one assumes an average density of one roe to 4ha (10 acres) of woodland over their entire range, the numbers of this successful animal can be imagined.

JOHN DORY: A STEALTHY PREDATOR

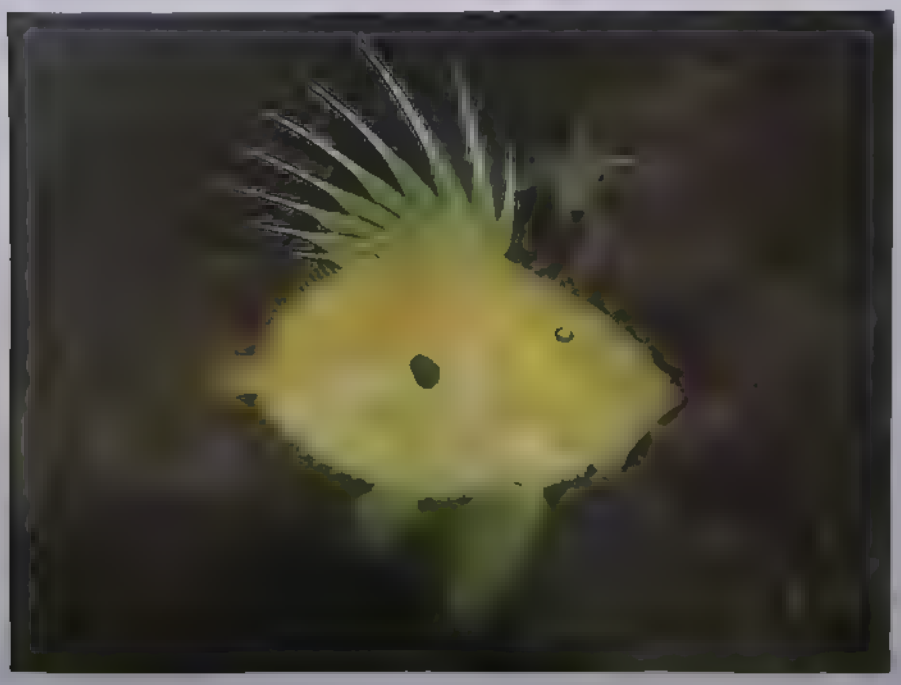
The John dory, a flattened, disc-shaped fish, is a slow swimmer: the secret of its hunting success is its quick-acting, protrusible jaws.

Above: The position of the dory's eyes gives binocular vision at close quarters. This specimen has unusually yellow lower fins (below)

The John dory is probably the most distinctive of all British sea fishes–the lugubrious expression on its face being memorable. Its body is flattened from side to side but is at the same time deep; the head is large, with big eyes placed high on the sides of the head. The most obvious feature, however, is the huge mouth with the bones of the upper jaw very mobile so that the whole top half of the mouth swings forward to form a protrusible scoop

Unusual appearance The edges of the body are armed with large hooked spines. These are most noticeable along the belly where they form strong spiny scales, and along the bases of the dorsal and anal fins where they are simply spikes. While the second dorsal fin and the main part of the anal fin are relatively small and low, the rays of the first dorsal fin are large, strong spines, and the first rays of the anal fin are detached and are conspicuously large. The dorsal spines bear long streamer filaments. The pelvic fin, too, has very long rays

In colour, the dory tends to be unremarkable except that on each side, more or less in the middle, it has a conspicuous black blotch about the size of the eye, surrounded by a yellow ring. Otherwise its body is dusky, often grey (though sometimes dull brown), but with distinct yellowish lines, and the ventral fins are jet black in nearly all cases



The dramatic eye spots on the sides of the John dory have led to a popular association with the biblical story of Peter taking the tribute money from a fish's mouth. The dark marks on either side of the fish were thought to be the thumb and finger prints of the Apostle. A similar legend involves the haddock, which also has dusky thumb-prints on its sides, but neither fish occurs in the Sea of Galilee, the scene of the miracle. The story is, however, sufficiently strongly associated with the John dory for it to be known as St Peter's fish in some parts of Europe, even in Scandinavia where it is not abundant.

Method of moving The dory is not a powerful swimmer. Dories are usually seen in groups, keeping station under moored boats or floating objects, by making gentle undulations of the dorsal and anal fins. They also live among kelp and near rocks, although from the frequency with which they are caught in trawls they must also live over open sandy bottoms In British seas the species is only really

common on the southern and western coasts, roughly from the Isle of Wight westwards to the Isles of Scilly and then along the Welsh and Irish coastlines. However, it does occur further east and north than this with moderate regularity, and is fairly frequently captured in the North Sea. Since it is not a particularly powerful swimmer, there is little doubt that at times, and perhaps from choice, the dory simply drifts in the sea's currents

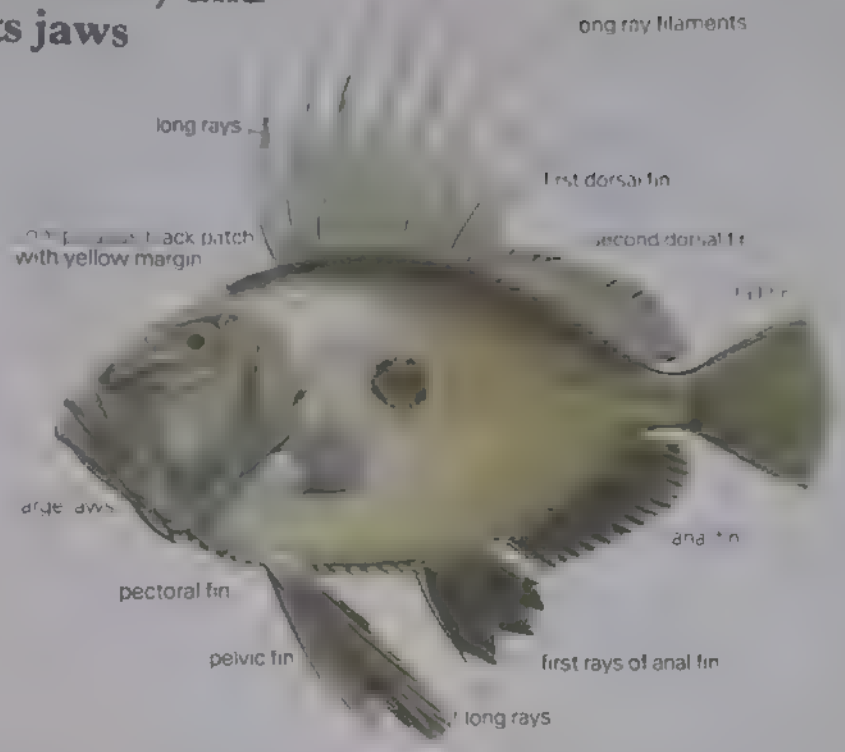
How the dory hunts The dory's weak powers of swimming, and its slow deliberate movements, can become a positive advantage to the fish when seeking food. Perhaps surprisingly, it eats fishes in large numbers, and it also captures cuttlefishes. Its food comprises almost any of the fishes common in the area in which it lives, and its method of catching these is by stealth.

From head-on, the very deep but narrow body of the dory is hard to see, and when hidden in cover the fish is almost invisible. The narrowness of the head also permits the dory to see objects close in front of its snout, and its forward binocular vision is helped by the mobility of its eyes in their sockets. Having sighted prey approaching, the dory keeps head-on towards it, slowly edging closer by means of gentle movements of the fins. When still some way away (the distance depending on the size of the dory) the jaws are shot forwards with incredible speed and the prey is swept into the mouth with the in-rushing water

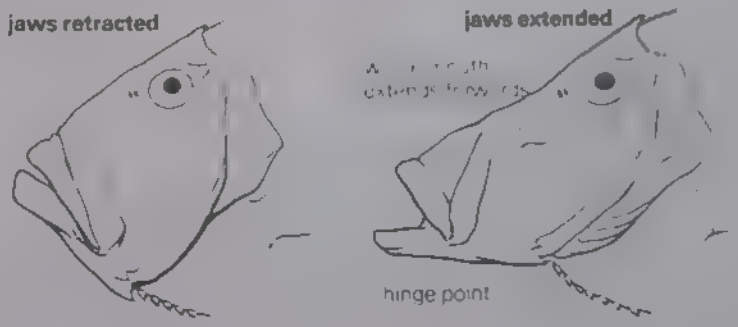
The remarkable efficiency of the dory's way of catching food is seen by the variety of fishes which have been found in its stomach. Herring, pilchard, pout, pollack, wrasses and gobies are all active swimmers which have been caught by the dory's stealth. Sometimes they eat large numbers of fishes–there is a record of a foot-long dory which contained twenty-five small flounders and three sea scorpions. This was evidently a fish which was using its excellent vision to spot food hidden on the sea-bed, and was probably swimming along in a head-down position–a posture they frequently adopt–while scanning the sea-bed

Late summer spawning In British waters the dory spawns during August. The eggs are small, about 2mm in diameter, and pelagic. They develop slowly: it is known that in the Mediterranean they take 12-13 days, so in our colder waters they may take three weeks to hatch. Within two weeks of hatching, the post-larva is recognisable as a dory; the large head and deep body are more or less the same proportion as in the adult–even a 6mm long fish is 3mm deep. At this stage, and for the next few months, they live in the upper 30m (16 fathoms) of the sea, and are more or less at the mercy of the tidal currents. In the English Channel those that are swept inshore join local breeding populations, while those reaching the North Sea do not breed.

The dory and its jaws



How the dory catches prey



Below: The dory is normally found inshore, in depths of 10-50m (6-30 fathoms). It grows to a size of some 40cm (16in) on average

Above: In one quick lunge, both jaws shoot forward while water rushes into the mouth, carrying with it the helpless prey

FLOWER COLOURS

Though the colour of a flower may vary from one plant to another (as in the white bluebell) its central function of attracting a pollinating insect remains the same.

Flowers are among the most beautiful and colourful structures in the natural world, yet it would be a great mistake to assume that they are attractive for our benefit only–or indeed for our benefit at all. A flower is an advertisement and, like all good advertisements, it is biased towards a particular group. In this case the group consists of any animal, bird or insect that will effect pollination

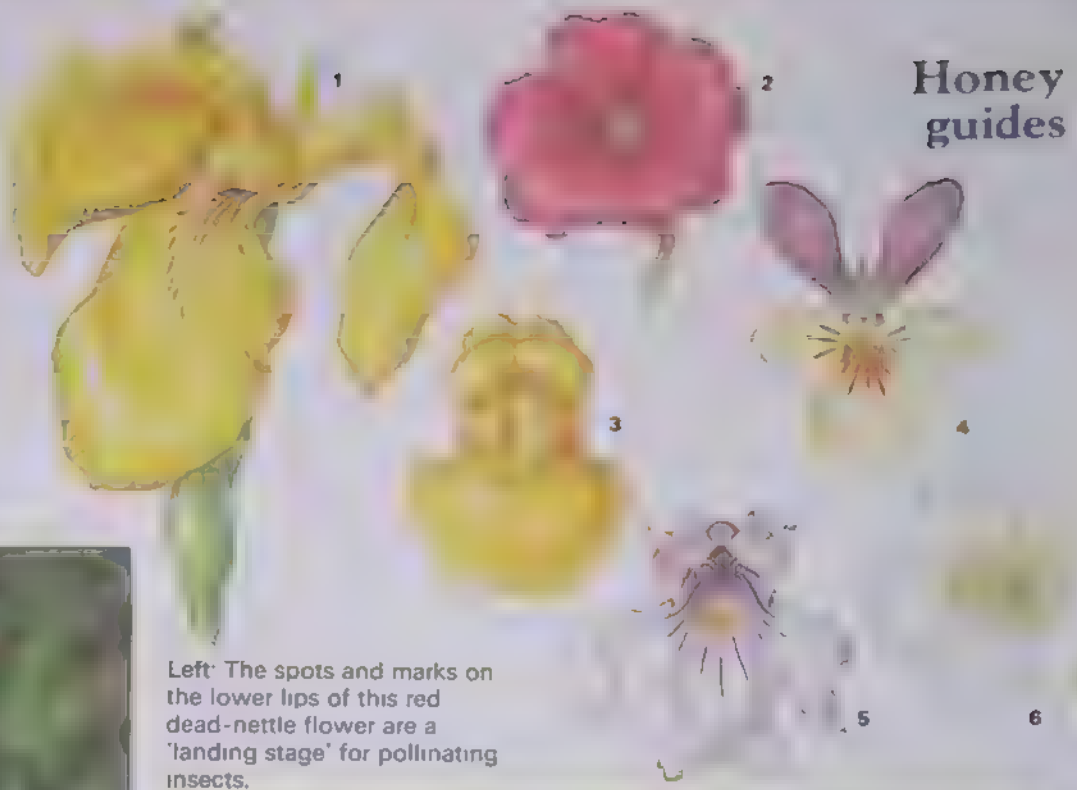
The relationship between pollinator and plant is one that has evolved gradually over a very long period of time. It is often so restrictive that only individuals of a particular species are able to pollinate a particular plant, though more usually plants can be pollinated by a range of species. Bees and wasps, for example, are often capable of pollinating the same species

Colour ads With the refining of this plant pollinator relationship plants have developed mechanisms to make themselves both more obvious and more attractive to their would-be pollinators. One of the most common methods employed is the use of colour. However, because we do not perceive the same colours as do other creatures, so the colours of a

Above White-flowered forms are particularly common among bluebells. Provided such colour variants are not at a disadvantage when it comes to being pollinated then they are likely to flourish. If, however, pollinating insects discriminate against them the population would begin to die out

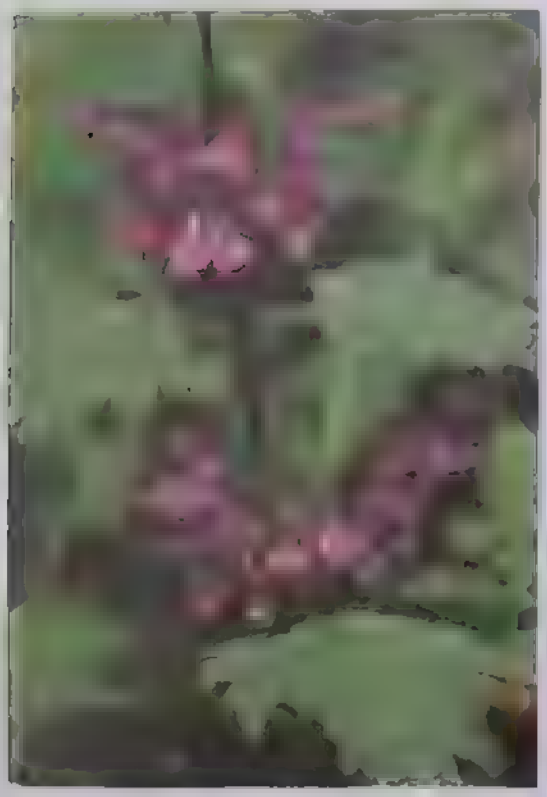
Left: To the human eye the flowers of silverweed look a uniform yellow, but to a bee the centre of each flower is much more brightly coloured than the outside, thus attracting it to the pollen.

Opposite right: Colour forms of the green-winged orchid. The green veins, which are honey guides for pollinators, show up particularly clearly on the pale form.



1 Yellow iris (*Iris pseudacorus*). Flowers from May to June
2 Bloody crane's-bill (*Geranium sanguineum*) Flowers July to August.
3 Common bladderwort (*Utricularia vulgaris*). Flowers July to August.
4 Wild pansy (*Viola tricolor*). Flowers April to September.
5 Common eyebright (*Euphrasia nemorosa*) Flowers June to September.
6 Grass of Parnassus (*Parnassia palustris*). Flowers July to September

Honey guides



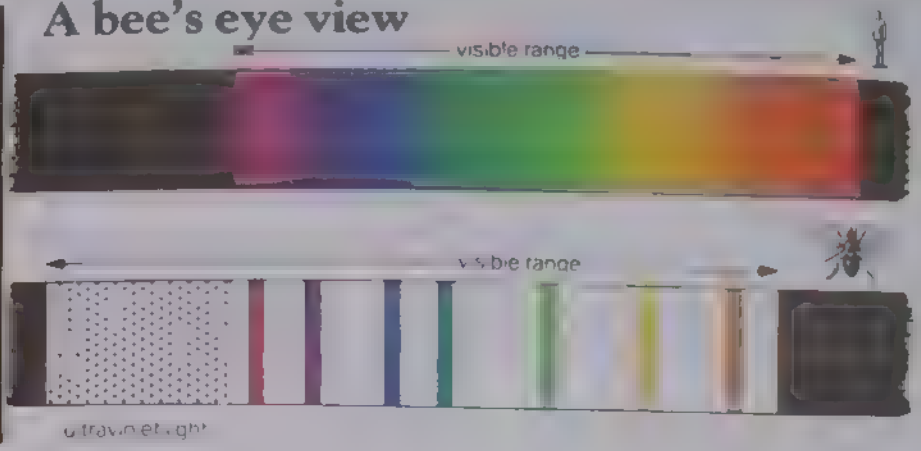
Left: The spots and marks on the lower lips of this red dead-nettle flower are a 'landing stage' for pollinating insects.

flower that we see are not necessarily those that are meant to be seen. In some cases the differences are startling. Take, for instance, silverweed, a common plant of disturbed ground with (to us) bright green leaves and uniformly lemon-yellow flowers. To a bee, however, the leaves appear grey-blue and merge into the background, and the flower looks very bright with the petals divided into two zones–a pale outer zone and a darker, more brightly coloured, inner zone.

The reason why a bee can see this inner 'eye' to the flower while we cannot is that a bee can detect ultraviolet light, which is invisible to the human eye. The leaves reflect ultraviolet light only weakly, so the bee ignores them, but the flowers reflect this light strongly, particularly the central part. The pollinating bee thus heads straight for the centre of the flower, where it finds the pollen.

Guides and landing stages Many flowers use colour in a slightly different way to attract pollinators. The flowers of bloody crane's-bill appear to us to be rose-pink with faint

A bee's eye view



The human eye can detect a range of wavelengths corresponding to different colours from red to violet–the so-called visible spectrum Immediately beyond the violet end of the spectrum lies ultraviolet light to which our eyes are insensitive Experiments carried out on bees however, indicate that they can see in the ultraviolet region as well as certain bands of colour within our visible spectrum (As compensation however bees cannot see the red end of the spectrum, nor is it known whether bees can, like us, see a continuous spectrum of colours) To discover how a bee sees a particular flower, therefore, we have to light the flower with ultraviolet light and record the image with a camera and film set to detect this light This has been done with fleabane, a member of the daisy family. The picture top left was taken under ordinary light, while the one below it was taken under ultraviolet light The result shows that whereas we see a fleabane flower as being uniformly yellow, a bee sees a flower with a dark centre This is because the outside of the flower reflects ultraviolet light strongly while the inside does not This dark centre guides the bee to the pollen and nectar

markings. When viewed under ultraviolet light the petals turn pale and the markings stand out as a strong network of lines converging towards the centre of the flower. These lines are called honey guides because they lead the pollinating insect towards the source of nectar, and also the pollen.

When seen under ultraviolet light at least half our native flowers can be seen to have honey guides, sometimes extremely sophisticated ones. In at least a quarter of all flowers these honey guides are visible to the human eye.

An example of plants with clearly visible honey guides are the two-lipped flowers such as red dead-nettle. These flowers also have spots and other markings on the lower lip–a feature found on foxgloves, whose lower lip is conspicuously marked with coloured spots on the inside. These spots mark a landing stage for pollinating insects and ensure that the insect is correctly orientated for obtaining nectar and pollinating the flower.

Rare red flowers Though bees can see ultraviolet light they are blind to red light, as indeed are most insects apart from a few tropical butterflies. For this reason there are hardly any red-flowered plants in the British flora. Birds, however, can perceive red light, though there are no British plants specifically pollinated by birds. This is a phenomenon almost unique to the tropics and accounts for the riot of very brightly coloured flowers found there. These plants are pitching their 'advertising campaign' at creatures such as humming birds and the few butterflies able to perceive red

Our most obvious red native plant, the poppy, is pollinated by insects, despite the colour of its flowers. These should appear almost black to an insect, though in fact the petals strongly reflect ultraviolet light and are clearly visible to pollinating insects

Below: Although the flowers of eyebright are extremely small–about 6mm across–their bright markings make them clearly visible to potential pollinating insects The yellow mark on the lower part of the flower acts as a 'landing stage' while the lines on the petals are honey guides

Colour variations A phenomenon frequently encountered by the field botanist is variability in flower colour. To take an example, the mountain pansy, whose Latin name of *Viola lutea* means yellow pansy, varies from bright yellow, to brownish-violet or red-violet. Populations of this plant occur in which all these colours are found in various combinations.

Clearly this is a situation in which the flower colour that we see bears little relation to the colours seen by a pollinator - indeed the basic colours of the flower can be of little or no interest to it. As long as the honey guides are present pollination occurs. In this situation a great degree of colour variation is able to occur.

Albino plants Occasionally a plant with normally brightly coloured flowers produces white flowers. This is a simpler instance of the colour variation in mountain pansy and is taken advantage of a great deal by plant breeders, who propagate from the white form and give it a special name - usually with snow or ice in it.

Left Probably the most attractive white-flowered form found in Britain is that of the fritillary, the normal purple flowered form of which is shown below. In southern England there is a meadow which is ablaze with fritillaries in spring and the white form seems to be increasing there. It is unlikely that the purple form is less successful than the white, so this is probably an example of genetic drift in which because of purely random factors, one colour form suddenly becomes much more common.

Below left White-flowered forms of foxglove show their markings particularly clearly. The large, more regularly shaped flower at the top is the result of a quite separate genetic condition known as peloria.

A number of plants are known to have a propensity to white flowers. Among these, the most striking is probably the foxglove–a stand of white foxgloves with the occasional spike of the more familiar purple form is always an impressive sight. White-flowered foxgloves seem to be more common in Scotland than further south. White forms of the field gentian can also be found in Scotland. In both cases this may be connected with the fact that colour variations are commonest among plants on the extreme limits of their range.

Perhaps the most attractive of all white-flowered forms is that of the normally purple-flowered fritillary. There is a meadow in southern England which comes ablaze with fritillaries during spring, and here the white form seems to be on the increase. It is unlikely that the purple forms are less successful than the white ones, so this is probably an example of genetic drift.

NATURE RAMBLING IN TATTON PARK

The extensive grounds of Tatton Park in Cheshire are ideal for nature exploration. Here we follow three walks round Melchett Mere in search of teal and sneezewort; a longer route past Tatton Mere to Dog Wood; and a trip to the Mill and Fish Ponds.

Right: A view of Tatton Mere lagoon. Because it is shallow, this lagoon (at the north end of Tatton Mere) is an excellent place for aquatic plants. Bur-reed fringes the edges, identified by its flat iris-like leaves and round spiny fruits, while among the rushes is the aptly named water-pepper—a plant you taste at your own risk!

The stately home of the Egerton family (now a National Trust Property) provides a noble setting for the exploration of its parkland—Tatton Park. Our three walks are all on fairly level ground.

Around Melchett Mere This walk takes about two hours of fairly leisurely strolling to complete. Melchett Mere was formed in 1936 as a result of subsidence associated with salt extraction. Approaching the Mere from the Old Hall Car Park, look for the tall, pink-flowered, great hairy willowherb in an ungrazed marshy area near the road. The small metallic-blue damselflies rest on the leaves here and on those around the meres. The shallows at the edge of the Mere provide just the right conditions for more marsh plants, such as the tall reedmace and the white-flowered water-plantain and smaller water-crowfoot. Teal frequent the area in autumn, at the same time as snipe are hunting for food in the boggy corners. Past the planted sycamores and horse chestnut, the path winds round the Mere's edge. If you are an early visitor, there may be cormorants fishing for their breakfast after roosting at Rostherne Mere nearby, or little grebes diving for small fish. Large numbers of coot and mallard build up here in the autumn after moulting.

Above: Growing along the edges of Tatton Mere the regal flower spikes of purple loosestrife stand out among the other plants, which may include soft rush and marsh forget-me-not.

Away from the Mere's edge, the grassland is typical of dry acid soils. Common bent-grass predominates, but if you look closer, it is intermingled with the pretty yellow-flowered tormentil and white sprays of heath bedstraw, while later in summer harebells are frequent. In contrast, the wet clay along the Mere's edge holds the water so that marshy spots have developed. Here you can find the small, round, umbrella-shaped leaves which belong to the marsh pennywort, while the yellow pea-like flowers belong to the greater bird's-foot trefoil. You can identify the pungent water-mint just by rubbing the leaves between your fingers.

The shallow water also teems with life. Whizzing along the surface are pond skaters, in search of any unfortunate small fly or other animal which becomes trapped in the surface tension. Water-boatmen paddle their way around in the water by using their flattened

Right: The tall reedmace (also sometimes known as the bulrush) grows among the shallows at the edge of Melchett Mere.
This Mere, Tatton Mere and also the marl pits shelter a most interesting range of plants and insects, and the meres are also renowned for their bird-life. The Park is therefore well worth more than one visit.

middle legs as efficient oars. The slower-moving pond snails glide on their muscular foot over the submerged plants.

In the open groups of trees, through which the path passes, flocks of tits flit from tree to tree in search of moth caterpillars and other insects. The common oak is the most valuable here since it plays host to more insect feeders than any other tree in Britain; and, even in winter, the twisted, grooved bark of the sweet chestnut makes it easy to identify. On the western side of the Mere, you may see some of the Park's red deer.

Tatton Mere to Dog Wood Longer than the previous walk, this one takes two to three hours. Again it is all very easy going.

All along the edge of the Mere and the lagoon at the north end marshy spots have developed, where the water is shallow. Here you can find more marsh pennywort, or the pink flowers of marsh willowherb, and marsh bedstraw with its sticky clinging stems and sprays of tiny white flowers. When there is no sailing, there can be a great variety of birds on Tatton Mere. The area is one of the best breeding sites for tufted duck in the country, and by the autumn up to 100 of these black and white birds are usually in residence. More

Below: A little grebe on its nest. If you visit the Park early in the day you may be lucky enough to see these birds diving for small fish The other name for this species is 'dabchick'

numbers after the for the little tail These breed sometimes present few pochard great , and the scarce water rail can sometimes be seen, while in the spring the striking goldeneye frequents the more se luded areas

The grasslands by the Mere are dry and acid, like those near Melchett Mere but you can still detect the old plough lines dating back to the 18th century. Hardy rye-grass dominates in the heavily used area near the boating slipway, but as you leave this area, other species appear. White clover flowers attract honey bees, and butterflies feed on the thistle flowers. The creeping thistle, which spreads fast by underground rhizomes, has pale mauve flowers, while the spear thistle's flowers are a rich purple and bigger. Peacock and small tortoiseshell butterflies cluster on the nectar-rich flower heads, but one of the commonest is the small heath

Beyond the grassland is an enclosed plantation of Corsican pine and red oak. Released from grazing pressure, the grasses are tall and showy. The cream flowerheads of Yorkshire fog, for example, stand out among the brambles and rosebay willowherb, and field voles thrive in the dense undergrowth. This contrasts with the open silver birch grove through which the path passes by the Mere

Dog Wood lies beyond a fence, near the end of the Mere. Although recorded as woodland in the 13th century, it has been greatly altered since. It is now dominated by two alien species: sycamore and rhododendron. The abundant bracken indicates the acidity of the soil, and masks the earlier-flowering bluebells Without grazing, a number of species have colonized and prospered. These include brambles, raspberry, ivy, enchanter's nightshade, honeysuckle and red campion. The narrower

fronds of the male fern enable you to separate it from the triangular outline of those of broad buckler fern. The tangle of trees and undergrowth provides houses for woodland birds. All three woodpeckers are here, the lesser following the flocks of tits which sometimes include the rarer marsh tits. The green woodpecker makes sorties into the grassland in search of ants, but nuthatch and treecreeper prefer to search the tree trunks for insects Grey squirrels may also be seen

To return to the car park, retrace your steps through Dog Wood and bear right at the gate diagonally up the slope. The open oak wood

Above: Around the Park's old marl pits you can find a range of insects, such as these green-veined white butterflies, whose larvae feed on crucifers

Left. In marshy spots at the edge of Melchett Mere you can find sneezewort, the smell of which, the great herbalist Gerard said, was enough to make you sneeze

Below: Tatton Park, showing the routes of the three walks in the order they appear in the article

was probably planted about 70 years ago, but the beeches are much older, having been planted around 1840. Beside the track are numerous hollows. These are marl pits and are characteristic of Cheshire fields. The marl, a lime-rich clay, was spread on the sand fields to improve the soil. The pits show all types of colonization, from dry grassy hollows to water-filled, marshy-edged ponds. Because of the high leaf-fall, those in the wood have silted up while those in the grassland still hold water

The Mill and Fish Pools The Old Hall houses an exhibition which is open to the public. From here a series of numbered information boards set out a medieval history trail. Our route–a gentle one and a half to two hour saunter–follows most of these and some provide useful reference points.

Immediately below the first group of boards a rabbit warren has been dug out in the sandy soil. These dry grasslands contrast with the tall ungrazed marsh in the valley beyond the boundary fence of public access land. The scattered willow bushes, in the matrix of great hairy willowherb, meadowsweet and soft rush, give cover for small mammals like shrews and voles, and a home for reed buntings.

By following the history trail to Board 10, you cross an area which, in the 18th century, was called a 'moor'. The dry soil now supports a typical acid grassland community, but heather may once have been more widespread. Meadows once existed between the board and the stream to the south but they have now reverted to marsh. The narrow banks across the grassland identify old hedge lines. Below the marsh at Board 12 there is a small mill pool, possibly of 16th century origin. Here, among the yellow water-lilies, the moorhen quietly skulks, the solitary heron fishes and the single mute swan preens and feeds on the water plants.

The track you cross to Board 13 can provide a short cut back to the car park. It is around here that you are most likely to see the red deer. The stags only mix with the hinds in the autumnal rutting season. Roaring and clashing their antlers, the stags vie with each other to collect as many hinds as possible in their harems.

Top: A herd of fallow deer grazing in Tatton Park. Red deer can also be seen, but they tend to be rather elusive The lower branches of the scattered beeches and oaks in the Park show distinct browse lines–but it takes quite an expert to discover whether the culprits are red deer, fallow deer, cattle or sheep.

Above: Narrow-leaved water parsnip–another plant to spot on the edges of the meres and marl pits.

Right: Keep a sharp look-out and you may see a goldcrest.

As you head towards the group of trees north of Board 13, you may detect the subtle change in the grass community as you pass from one dominated by common bent to an area which was once more intensively used and now harbours sweet vernal grass, red fescue, Yorkshire fog and white clover. If you approach the fish pools quietly, you may see herons searching for frogs and other titbits All round the larger pool to the right are huge mounds of tussock sedge, a species of wet fens The tussocks keep the stem bases and new buds out of the water, thus ensuring an adequate supply of oxygen. The tubular hollow stems of water horsetail are another adaptation, enabling oxygen to pass quickly from the air to the water-logged roots below By contrast, the stems of the field horsetail in the grass above the pond are solid

Old Hall Car Park lies behind the group of newly planted trees to the west which are protected by tree-guards. These prevent not only the sheep and red deer, but also the fallow deer, from browsing on them. Fallow deer are smaller than the red deer and have a dappled cream coat on a pale to dark brown background and flattened ends to the antlers. Although excellent for grazing animals, these grasslands provide few opportunities for many bird species. Large numbers of a few types therefore tend to occur, such as the speckled brown meadow pipits, and the flocks of lapwings. A few curlew and golden plover also pause here, usually *en route* to their winter feeding or moorland breeding haunts.

WEEVILS OF BRITAIN

Most plants support one or more weevil species—a group of beetles which, through their secretive habits and wide taste in food, are extremely successful.

With some 500 species in Britain, weevils are an extremely successful group of insects, coming second in number only to the rove beetles. Most weevils confine their attentions to feeding on wild plants, but a minority are important pests of agriculture and forestry—these are the species most familiar to us.

Weevil features Weevils are characterised by an elongation of the head into a curved hollow beak or rostrum, which has tiny mandibles at the end for chewing food. The rostrum varies in length according to the species and also the sex: those of the females are often much longer than those of the males as they are used for piercing stems, roots and fruits in which to lay the eggs.

The majority of Britain's weevil species are only a few millimetres long, although a small number attain greater sizes. The large pine weevil, for example, is 10-12mm long, and the two rather local species of *Liparus*, which occur principally in grassy areas in south-east England, are 12-15mm long.

Life-cycle Nearly all weevils are herbivorous, both as adults and as larvae. The adults generally feed more openly—if often nocturnally—on leaves, stems and flowers, whereas the larvae are typically enclosed within fruits, seeds or roots. Quite frequently, adults and larvae feed on different parts of the same plant.

Since weevil larvae live enclosed and surrounded by their food or soil, they tend to be colourless and soft-bodied, although the head is hard (due to the presence of chitin) with powerful biting, chewing jaws. Weevil pupae are of the exarate type with 'free' limbs, wings and antennae, and are usually enclosed within a cavity of the food plant or protected by a cocoon. The whole life-cycle generally takes a few weeks or months, but may be considerably longer in wood feeders, such as the pine weevils.

Plant feeders The insidious feeding methods of weevils make them difficult to control and are exemplified by those species which attack cultivated plants. The 5mm long pea and bean weevil, for example, attacks seedling pea and bean plants by chewing semi-circular pieces from the edges of the leaves. The adult weevils —pale greyish-brown with two darker stripes on the thorax—are rarely in evidence during the day, but if a gardener examines his plants

Above: Nettle weevils (*Phyllobius urticae*) mating

Right: The grain weevil (*Sitophilus granarius*) is a pest of stored grain and flour products. Discovery of this species in Egyptian grain deposits dating from 10BC is proof that this species has caused man trouble for many centuries. Somewhat more recently the weevil's presence in ship's biscuits made this food unpopular with sailors and was a common cause of unrest

Two weevils which are a nuisance in woods are the banded pine weevil which attacks coniferous trees and the beech leaf miner—a tiny weevil with larvae that feed on beech leaves, causing a brown curling. The vine weevil feeds on vine stems and leaves, and house plants. Garden pests include the brassica weevil which causes galls on root crops and brassicas, and the pea and bean weevil, an attacker of pea and bean seedling plants.

at night with the aid of a torch he will see the weevils clustering on the leaves in considerable numbers

During the day the adults spend their time in the soil close to the stem. Here the females lay their eggs so that when they hatch the larvae can attack the plant's roots

The vine weevil feeds in a similar way to the pea and bean weevil, but on strawberry plants and sometimes greenhouse pot plants and the growing wood of vines. Reproduction in this species, as in some other weevils, is by parthenogenesis (reproduction without fertilisation), the males nearly always being absent

Much less secretive in their habits are the bronzy-green nettle weevils. Often extremely common, these weevils can be seen resting, feeding and mating on sunny patches of nettles in the summer. The species owes its metallic coloration (darker and more coppery in the larger female) to a covering of fine, scale-like, light-reflecting hairs. Nettle weevil larvae feed on the nettle's roots and pupate in the soil

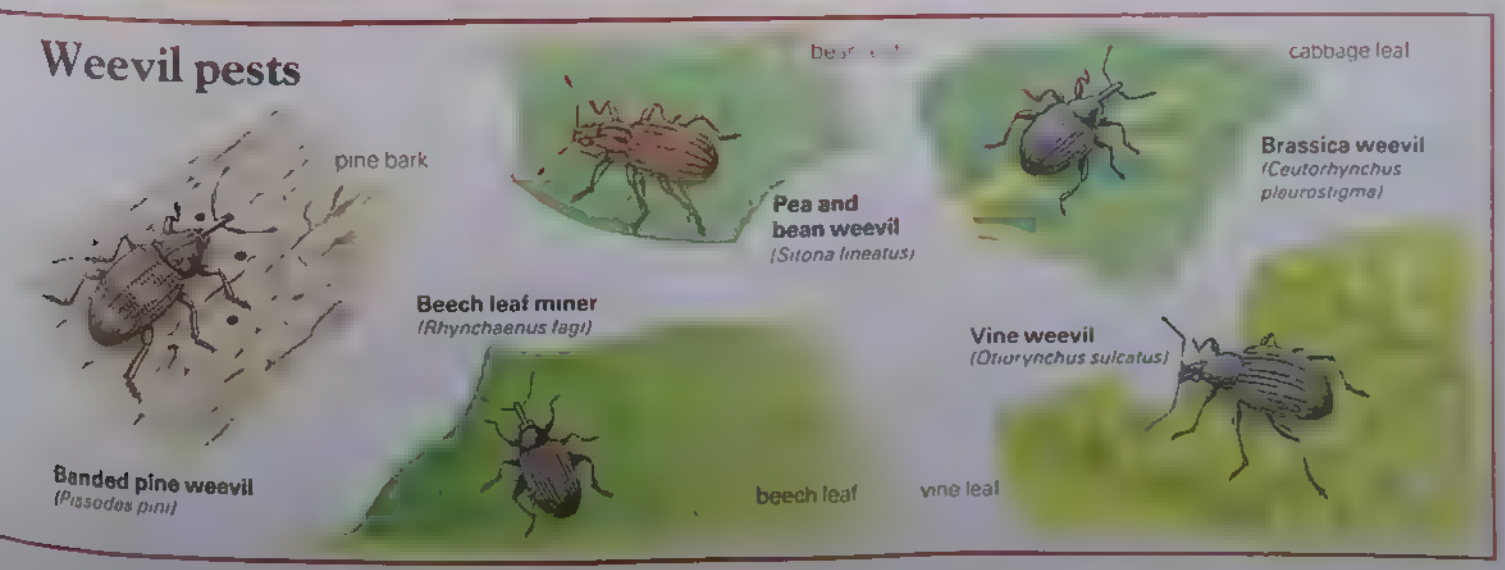
Above The large pine weevil (*Hylobius abietis*) is a forest pest the adults feeding on the bark of both mature and sapling conifers

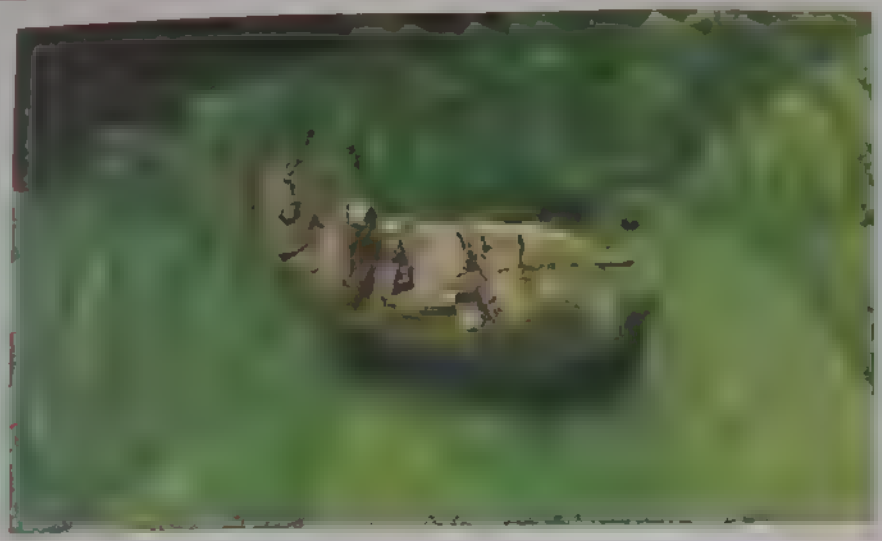
The small size of many weevils is indicated by the fact that the larvae of the sub family Rhynchaenidae feed by mining between the cuticular surface of leaves on elm, oak, beech and sallow. One example of a species with leaf mining larvae is the beech leaf miner, the larvae of which cause a characteristic brown curling of the leaves

Seed-eaters Some of the most interesting weevils are those whose larvae feed on seeds. The gorse weevil subsists within the seed-pods of gorse, and unlike other species does not bite its way out on maturing but waits until the plant's pods naturally ripen. As the pods burst open—with an audible cracking noise—both the seeds and the weevils are dispersed widely by the propellent force of the action. It seems clear that gorse weevils have adapted and delayed their emergence to take advantage of what is, in effect, a means of dispersing the species more widely over a limited area and thus reducing in-breeding

At times the gorse weevil is so populous that it substantially reduces the host plant's seeding viability. For this reason the species has been introduced to New Zealand in an attempt to reduce the spread of gorse

Grain store pests Among the most economically damaging species are the grain weevil





Safety in the guise of death

Weevils defend themselves from predators in a number of ways. Some are so small and inconspicuous that they are unlikely to be noticed by hungry birds, while others are camouflaged, nocturnal, or live deep within the buds, flowers or leaves. If discovered, however, weevils employ an interesting predator-avoiding device known as thanatosis. When touched, a weevil shams death by simply falling to the ground with its legs partially drawn up to its body. (The picture on the left shows a nettle weevil shamming death.) The ploy has obvious value against insectivorous birds, which only notice weevils on vegetation—not those on the ground—and may also work quite well against terrestrial predators, such as toads, that only catch moving prey

and its more specialized relative, the rice weevil (*Sitophilus oryzae*). Probably originating in the Near East, neither species is native to Britain, but each has established itself almost worldwide through international trade

In Britain, and other countries with temperate climates, these weevils cannot exist outdoors so they live in granaries and flour mills. Here the females lay their eggs in the stored grains of wheat, barley and maize, afterwards sealing up the hole made with their rostra by means of hardened saliva. Except in crowded conditions, only one egg is laid in a grain, where the whole larval development takes place until the adult bites its way out, leaving behind an accumulation of frass and shed cuticles. Heavy grain weevil infestations are commonly accompanied by the presence of mealworms, since the latter prefer feeding on grain which is broken or damaged

Timber pests A number of weevil species have taken to eating timber. Of these one of the most damaging is the large pine weevil, a considerable pest of forestry on the Continent. Adult beetles hibernate in the ground, and in spring feed on the bark of both mature and sapling conifers. The pine weevils' feeding method is particularly damaging as, in order to reach the succulent young bark and cambium layer the weevils prise off the outer bark, which is not only harmful in itself but may pave the way for attack by other insects as well as fungi. The adults are capable of living several years and thus can build up large populations.

By curious contrast the pine weevils' larvae are less damaging to the trees since eggs are laid in old stumps and logs, and the larvae feed within the dead wood, pupating there the following year.

A rather smaller enemy of coniferous trees is the banded pine weevil, both the adults and larvae of which feed on living trees. The larvae are particularly harmful because they bore tunnels between the bark and the wood.

One method of controlling these weevils is to provide lures of fresh pine wood which have been scored to promote resin flow and attract the weevils. Natural enemies, such as parasitic ichneumon and braconid wasps also do much to control the weevils by laying their eggs in the weevil larvae, right through the bark of the tree

Weevil galls A variety of insects induce the creation of gall formations on plants as a direct result of their feeding, and there are a number of weevils whose host plants react in a similar way. For instance the reddish nodules on the stems of docks are caused by the orange-red *Apion frumentarium* larvae, while the brassica weevil *Ceuthorhynchus pleurostigma* and other members of the genus cause characteristic small round swellings on the roots of cultivated brassicas, and on root crops.

Below: A pair of weevils (*Apion* sp.) mating. Notice the typical weevil features—an elongation of the forepart of the head into a curved hollow beak or rostrum which has tiny mandibles at the apex, used for chewing food. The length of the rostrum varies according to the species of weevil and whether it is male or female Females tend to have slightly longer rostra than males as they pierce stems, roots and fruits into which they lay their eggs.

FREE FLOATING AQUATICS

Despite the threat of being washed away, the precarious life of floating on water gives a plant many advantages over its rooted competitors.

Some of the most successful plants in our ponds and rivers are not rooted to the bottom of the water but are freely suspended, sometimes floating on the water surface. Such a way of life offers important advantages, as you may expect when you consider how successful these 'rootless' plants can be in cutting out the light from plants lower in the water. The most important advantage is that they can float up and down as the water level fluctuates. In this way they obtain the maximum amount of light for photosynthesis. Plants rooted to the riverbed, on the other hand, may dry out if the water level drops or, if the water level rises, they may become too deeply submerged to be able to photosynthesize efficiently.

Yet there are disadvantages in being rootless. Being freely suspended or floating imposes a number of fairly rigorous constraints on the choice of habitat. Such plants usually flourish only in still or slow-moving water and are therefore prevalent in sluggish rivers, canals, drainage ditches, ponds, lakes and reservoirs. Only those species with a particularly high reproduction rate will succeed in moderately flowing water because they are able to replace those individuals washed downstream by younger ones from above. Also, most rootless plants are found only in waters rich in nutrients and basic materials. This is because they can obtain their nourishment only from the water whereas other aquatics get most of theirs from the soil in which they root.

Free-floating characteristics Whatever the shape or size of the plant, one feature they have in common is buoyant leaves. This is achieved by having at least 70% of the leaf volume as air. The distribution of this air and its extent vary in different species and with the environment. Species that float on the surface have to be more buoyant than water but those that suspend themselves below the surface must have an even more precise internal buoyancy regulation. They must not be too deep to reduce effective photosynthesis yet they must not reach the surface where their delicate leaves cannot resist desiccation.

In floating species the leaves on the surface

Above: Common bladderwort (*Utricularia vulgaris*) is an exception to the rule that most free-living aquatics are found in nutrient-rich waters. It thrives in the nutrient-poor waters of peaty fen ditches and ponds, where it succeeds by being able to derive extra nourishment from trapping and digesting small animals.

Right: Common duckweed (*Lemna minor*) survives in quite fast-flowing rivers by multiplying rapidly to replace plants washed downstream.

Above: Frog-bit (*Hydrocharis morsus-ranae*) overwinters as a turion (bud) resting on the pond bottom. Here it is sprouting in spring

Below: The rounded, kidney-shaped leaves of frog-bit

of the water are generally succulent and rigid However, unlike most land plants which gain rigidity from thickened, often dead tissue, they achieve this primarily through turgor, which is inflation of living cells by water Another feature of plants that float on the surface is the modification of the roots. Freed from the function of anchorage, many produce large numbers of long trailing roots which are covered in fine root hairs. Apart from obtaining all the nutritive needs of the plants from the water, these may also act as underwater stabilisers which prevent the buoyant floating leaves from rolling over They may also become entwined with rooted vegetation thus preventing them from being washed or blown away

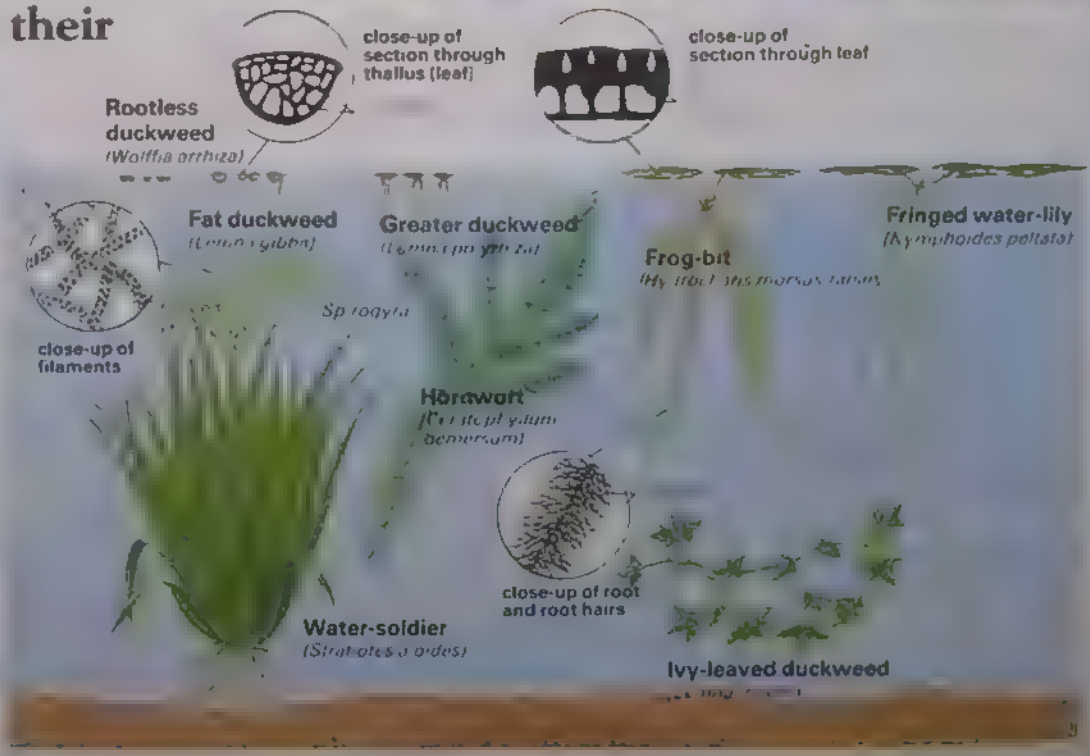
The range of variation exhibited by freely suspended or floating plants is immense. Even if the thousands of minute planktonic algae, which sometimes turn water into the colour and consistency of pea soup, are discounted, there are still hundreds of examples of free-living algae, bryophytes (mosses and lichens), ferns and flowering plants

Free-living algae In Britain many large filamentous algae can grow rapidly in stagnant or slowly flowing water. The slimy bright green *Spirogyra* is perhaps the best known, though three other green filamentous algae are far commoner and may cause much greater problems in rivers and ponds

All three species usually start their lives attached to a substrate but soon take to the freer life Blanket-weed (*Cladophora*) is the most adaptable, being able to grow on rocks in fast-flowing water, yet when the water is sluggish it becomes detached and frequently forms huge rafts of yellowing scum at the surface of the water. It has a relatively tough texture which contrasts with the softness of cot (*Vaucheria*). This is a brighter, darker green alga and invariably starts its growth on the sandy or muddy surfaces before becoming freely suspended. The third alga likely to cause problems in rivers and ponds is tube-weed (*Enteromorpha*), a most characteristic species which starts life as very thin strands

Free floaters and their root systems

Free-living aquatics are rootless only in the sense that they are not rooted to a substrate. In fact the roots of such plants are vital for absorbing nutrients from the surrounding water. In frog-bit and hornwort, for example, this process is made as efficient as possible by the plants having thousands of very long, fine root hairs to increase the surface area over which the absorption takes place. In some plants, particularly the floating duckweeds, the roots also act as stabilisers, preventing the plant from rolling over in the water



which then enlarge as they grow older to become long cylindrical tubes up to 2m (6ft) in length and 3cm (1in) in diameter

Floating bryophytes The best examples of truly suspended bryophytes are two closely related liverworts, *Riccia fluitans* and *Ricciocarpus natans*. Neither is common since both only frequent water that is very rich in nutrients and stagnant or barely moving. They are thus confined to lowland ponds, ditches and canals where they may be found floating on the surface among duckweed

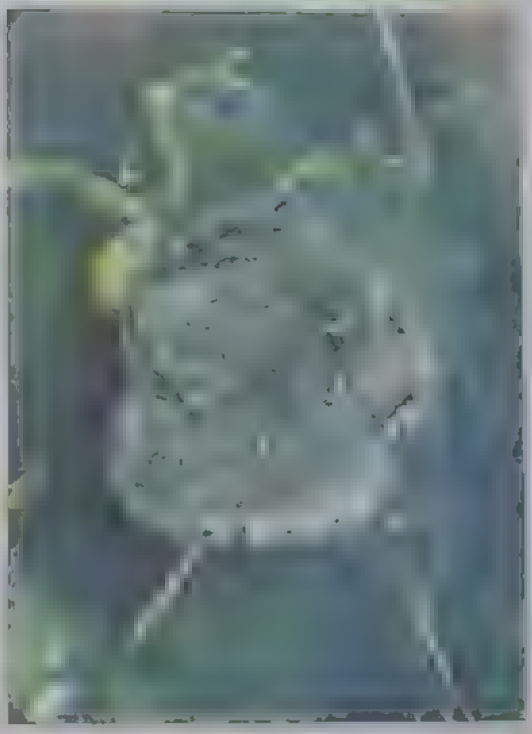
Fern relative The fern-like plant *Azolla filiculoides* is a surface-floater and does not in the least resemble a fern; indeed, in the early days of classification it was thought to be a liverwort. The frond is divided into two parts, each with a distinct function. The reddish-green upper part floats and performs the vital function of photosynthesis whereas the almost colourless lower part is submerged and serves to absorb water and nutrients

Flowering plants The majority of freely suspended or floating flowering plants are monocotyledons. The only successful British example of a free floating dicotyledon is the fringed water-lily. It is a rare and endangered plant with beautiful flowers borne proudly above the slightly wavy-edged leaves

There are two genera of submerged yet rootless dicotyledons. The hornworts, of which there are two species, have a tough, rough texture with rigid yet finely dissected leaves radiating from a central stem. At their tips this rigid growth can make plants resemble underwater cones. Bladderworts are a rare example of plants being able to thrive in nutrient-poor water without being rooted in the substratum. They manage this by feeding on insects and other small invertebrates which they trap in small bladders

Duckweeds The range of monocotyledons capable of a free-living existence is much greater than that of the dicotyledons. Small surface-floating species are commonly called duckweeds, and three of the commonest belong to the genus *Lemna*. The largest is greater duckweed, each plant resembling a flat plate up to 1cm (½in) across

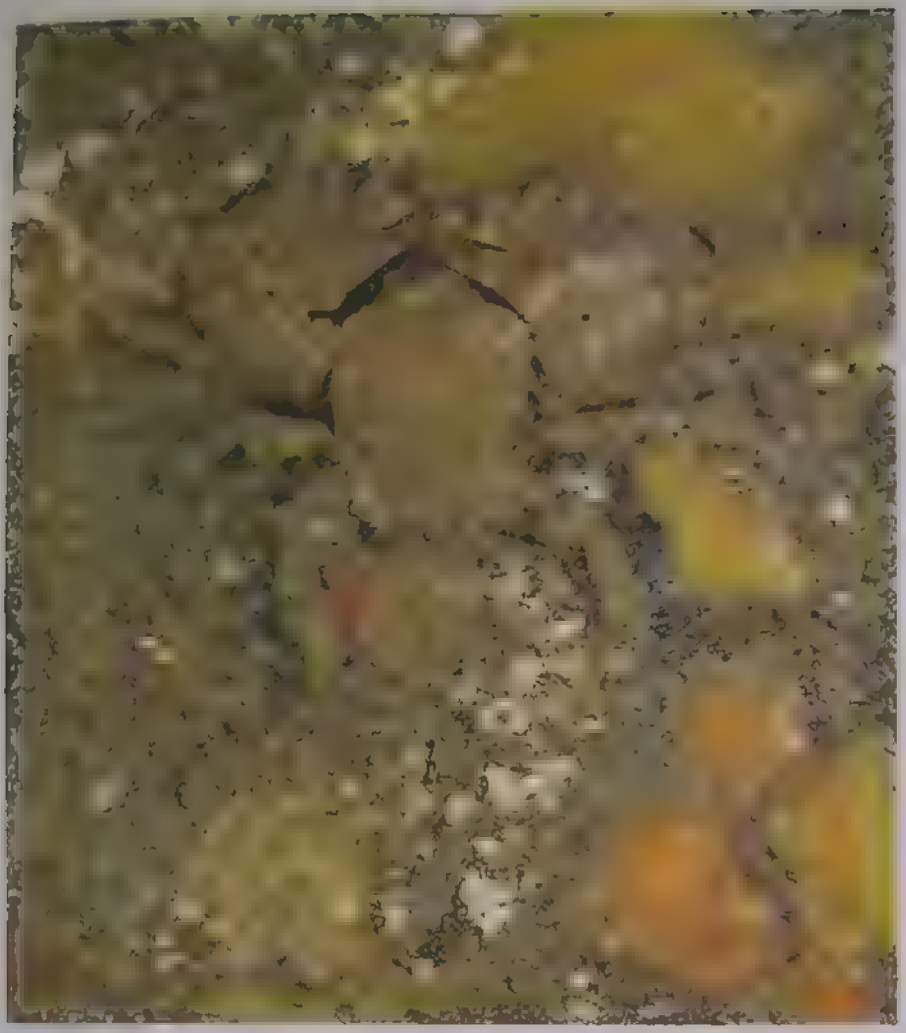
In the same family, but belonging to a different genus – *Wolffia* – is rootless duckweed, a rare plant found mostly in marsh dykes. It is famed as being Britain's smallest flowering plant, though it has yet to be observed in this country bearing flowers! Ivy-leaved duckweed, though a species of *Lemna*, is a submerged plant. It is most characteristic of nutrient-rich drains and ponds, and is often found entangled with other plants. Another submerged but free-living monocotyledon is water soldier. This highly adaptable plant rises to just below the surface during the summer to ensure that it is not overcrowded by other plants and to ensure that its flowers are borne above the surface of the water. Then during winter it sinks to the bottom to avoid frost and the risk of being washed away.



Above: The fringed water-lily is a free-floating aquatic unlike the unrelated yellow and white water-lilies which root into the bottom of the water. The fringed species occurs only in very sluggish or still waters, often just at the edges where weeds and other vegetation prevent it from being carried away by wind or currents

Right: A selection of rootless algae: thick strands of tube-weed (*Enteromorpha*), a large raft of the blue-green alga *Lyngbya*, and fine strands of blanket-weed (*Cladophora*)

Below: The free-floating liverwort, *Riccia fluitans*, with its long, thin, sparsely branched thalli



DIMINUTIVE PORCELAIN CRABS

Two tiny British crab species belong to the large family of porcelain crabs, so called because of the shiny shells of their overseas relatives.

Above: The hairy covering of this broad claw porcelain crab has acquired a layer of mud. One advantage this brings is relative safety from predators, because it is so well camouflaged. Porcelain crabs are also camouflaged by being the same colour as their surroundings

Below: A group of long claw porcelain crabs gripping on to a rock surface. Each one has the colour of the spot where it was collected.

The intertidal region of the seashore offers ever changing conditions to its inhabitants. Exposure at low tide, extremes of temperature, changes of salinity and the punishing effects of storm waves are all hazards to which shore dwellers are subjected. Many animals living in this region show obvious adaptive features that meet particular problems related to their life styles. Barnacles, for example, have wave-resisting armour and are clamped to the rock, and mussels have tightly closing shells to conserve water.

In other shore dwellers, adaptive traits are not particularly obvious, though these are nonetheless present. This is perhaps true of the porcelain crabs, which are often present in large numbers in suitable intertidal regions. Their chief adaptations lie in their ability to conceal themselves: they are easily overlooked on account of their small size, their colour, which often matches their background, and their habit of remaining motionless when disturbed.

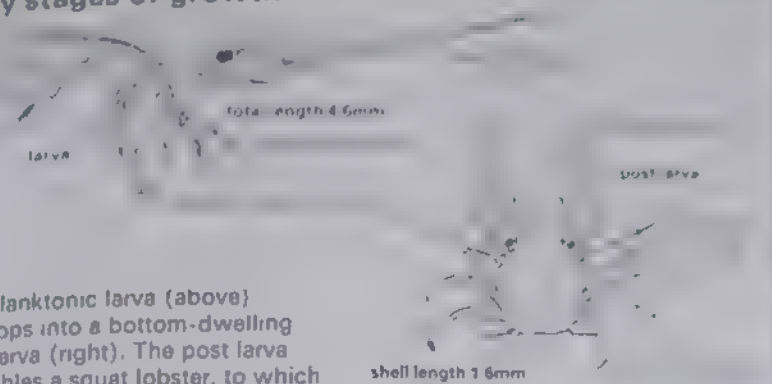
Intertidal species The species of porcelain crabs inhabiting our coastal waters are diminutive representatives of a family called the Porcellanidae, which contains a considerable number of species of diverse shapes, habits and habitats. The majority occur in tropical and subtropical regions, and some live in close association with other marine invertebrates. Two species are found on the middle to low shore in British waters. These are the broad claw porcelain crab, *Porcellana platycheles*, and the long claw porcelain crab, *Pisidia longicornis*. The latter species often extends downwards beyond the intertidal zone to about 30m (16 fathoms). Both species are relatively small; the broad claw porcelain crab reaches 14-16mm ($\frac{1}{2}$-$\frac{5}{8}$in) in shell length, and the long claw 8mm ($\frac{3}{8}$in), rarely 10mm ($\frac{1}{2}$in)

A close examination of either species shows that each side of the shell is composed of a narrow movable plate, not fused with the mouth frame; the feelers (antennae) are placed to the outside of the eyes, and only four pairs of legs are clearly visible. The fifth pair is usually tucked away from view beneath the sides of the body shell. The tail of the abdomen is composed of a number of small plates, and the last pair of abdominal limbs is flattened to form part of the tail fan. These features are characteristic of squat lobsters and their relatives, and indeed porcelain crabs are closely related to that group.

Hiding among rocks Both species spend most of their life clinging to concealed rock surfaces, in interstices, or on muddy sand beneath rocks, boulders and seaweed. Although small, they are able to exert a considerable hold on apparently smooth surfaces, and are often difficult to dislodge. Sometimes they even prefer to shed limbs rather than be removed.

The grip they exert on such surfaces can

Early stages of growth



The planktonic larva (above) develops into a bottom-dwelling post larva (right). The post larva resembles a squat lobster, to which porcelain crabs are related

usually secure the crabs against quite vigorous wave action. They accomplish this by spreading the three pairs of walking legs on both sides and using the curved, sharp claws as anchors while pressing the flattened body against the rock surface

Grooming and feeding The usually hidden fifth pair of legs is used for cleaning out particles from the gill chambers and for grooming the other legs and the body. These two legs are invested with suitable brushes of hairs, and although the legs are small they are able to reach forward, from beneath, to the front of the body. Here particles collected on the brushes are scraped off by the second pair of external mouth parts. Much of the detritus collected in this way is rejected, but some may be eaten; thus this activity serves a two-fold purpose

The chief method of feeding, however, is by sweeping the outermost pairs of hairy mouthparts through the water and filtering out suspended particles. Particles trapped in this manner are combed off by hairs on the inner mouthparts and passed to the mouth

Eggs and larvae Little is known of the mating behaviour of our two species of porcelain crabs. Females carry eggs attached to the small limbs on the abdomen. The eggs are orange when first spawned, turning brown to almost black when near to hatching. In general, the broad claw species breeds from March through into August, and the long claw from April to October. The larvae that hatch are quite spectacular, having very long shell spines that extend forward and to the rear. These spines probably assist with buoyancy control, as the larvae can remain suspended in the water when not swimming. The larvae swim in either a vertical or a horizontal direction, and move head first, but because of their long spines they are unable to change direction rapidly.

The larvae feed upon smaller organisms in the plankton, and even upon each other. Growth is accomplished by moulting, each stage becoming larger. The final moult that takes them from the planktonic to a bottom-dwelling life also brings about a change of shape and a resemblance to the adult crab.

ing crabs grow rapidly, moulting claw species is thought to become sexually mature at one year old

Testing the water Exposure, particularly at extreme low tides, can leave populations of un crabs vulnerable to desiccation n very hot days The crabs may be seek out other pools as their own dry out, but total immersion in a pool of too little alinity (diluted by a freshwater example, or by rain) could pr on the broad the crabs can test the salinity of such po immersing only the tips of one or more walking legs, and thus avoid entering unsuitably diluted sea water

Above: The underside of a broad claw porcelain crab The abdomen is curled under the body. The crab's hairy limbs, the outermost pair of mouthparts and the plates composing the tail fan are all visible

Britain's porcelain crabs

FLOWERS, FRUIT AND VEGETABLES

From modest origins in the suburban market garden, fruit and vegetable crops have moved into the big field and today are the subject of a highly capitalised industry. However, market gardens and pick-your-own farms make a good living as well.

Growing fruit and vegetables is difficult, particularly with the need to cater for the most demanding and fickle of customers. The produce must be fresh, regular in shape, blemish-free, colourful and clean; the buyer looks for an appetising appearance, and for many people the taste or food value is of incidental importance. This curious state of affairs makes life difficult for the grower. Food value and taste are relatively easy to achieve, for these qualities are largely intrinsic to the crop, but maintaining a high standard of appearance demands a special combination of hard work and technical ingenuity.

Perfect conditions First and foremost the soil has to be in ideal condition: cultivated to just the right depth and consistency, maintained at the correct level of fertility and moisture, by irrigation if necessary, and kept free of weeds and pests. In most cases the plants need to be carefully established at regular intervals, either by precision planting machinery or by subsequent thinning out. They must be protected from birds and other animals, sprayed against insect and fungal attack, and shielded from extreme weather. The harvest is usually an operation of some delicacy for most of the crops are easily damaged by rough handling; in some cases – strawberries for example – hand labour is the only practical method. The crop has then to be cleaned, graded, packed, and if necessary, stored under controlled conditions before despatch to the market or processing plant.

Above: A field of cos lettuces. A high proportion of the country's fruit and vegetables are now grown on a big scale, and it is common to see whole fields of lettuces, carrots, celery or onions, Brussels sprouts, cabbages or cauliflowers, all regularly spaced in neat rows stretching to the skyline. A variety of equipment is used to establish, maintain and harvest the crop, from familiar farm implements to complex and costly special-purpose machinery.

The expense of all this is such that there must be a good reason to choose horticulture in favour of conventional arable farming. Traditionally the main factor was proximity to an urban market, coupled with high land values which encourage intensive cropping of valuable produce. This was the origin of the market garden where a wide variety of crops were produced to spread the workload and the risk, and reduce the danger of flooding the market and so lowering the price.

The relatively small area occupied by each crop encouraged the individual attention which distinguishes the gardener from the arable farmer, and indeed the whole enter-

prise was but a larger, commercial version of the private kitchen gardens which fed the rural population. Market gardening still flourishes, but it is now an intensive, highly capitalised industry

In rural areas the decision to grow certain vegetables and fruit usually depends on the climate and soil, giving the local grower an advantage over the suburban market gardener who normally has to provide these conditions artificially. Examples include open air tomato growing on Jersey, in competition with the glasshouse produce of the mainland, and the crops of leeks and onions from the rich fenland peat soils of Cambridgeshire

The drawback of rural horticulture - its possible remoteness from a major outlet - is turned to advantage by supplying a number of markets simultaneously, so allowing a grower to specialise in the crops best suited to the locality. Cauliflowers, for example, prefer a cool, damp climate, but will not tolerate frost; their cultivation is a speciality of mild coastal regions. The growers enjoy the advantages of specialisation and co-operative marketing, while wide distribution removes the danger of a local glut

A feature common to nearly all these rural enterprises is their relatively large scale. A traditional market gardener employs small plots suited to manual labour, but the adoption of mechanical and chemical systems of weed and pest control has made this unnecessary. And the economics of investment in machinery and materials improve as the scale of the operation increases, so there is every encouragement to use larger units

The right conditions Thorough cultivation is essential for most vegetable crops, and the seedbed is prepared with unusual care using mainly traditional methods: the soil is turned over by a plough, broken down with a heavy cultivator, and crumbled to a fine texture using harrows and rollers.

Planting is complicated by the need for careful spacing and the fact that many crops, for example leeks and Brussels sprouts, are transplanted at seedling stage, having been raised under glass. Traditionally the spacing problem is solved by hand thinning, but large-scale growers rely on precision seed drills to place seed at regular intervals. Small seeds, such as lettuce, are often pelletised to ensure consistent handling by the machinery. The transplanting of fragile seedlings is difficult to mechanise and automatic transplanters are expensive. For those who cannot justify the cost, it is a job for human fingers, and only the ultimate value of the crop makes such a labour-intensive operation worthwhile.

Regular spacing of plants is important to encourage even development and the mechanisation of subsequent field operations. Many vegetables are planted in single or double rows so machinery can pass up and down to remove weeds without causing damage to young plants.

Above: Commercial glasshouses in the Lea valley and (right) intensively cultivated cucumbers. Market gardens still flourish on the outskirts of towns but the cost of land, labour and materials has forced a concentration on the more valuable crops such as aubergines, courgettes and capsicums (peppers), grown under acres of glass along with tomatoes, cucumbers and early lettuces. It is a very intensive, highly capitalised industry

Below: Potato picking near Wickham Market in Suffolk

The technique of inter-row cultivation was once the principal means of weed control on every farm, but in recent years it has been all but abandoned in arable fields in favour of a carefully planned spraying programme. A similar approach is being adopted increasingly by the large-scale vegetable and fruit growers who are finding the purchase and application of specialised herbicides a cheap option compared to repeated time- and fuel-consuming cultivations.

This development, coupled with the well-established use of chemicals to maintain the flawless appearance demanded by the average consumer, has made the simple spraying rig essential equipment. Skill in the laboratory is

Above: Although green peas are relatively easy to establish, they are difficult to harvest economically. But such is the market for frozen and tinned peas that the processing companies find it worthwhile to buy special machines, despite their cost, which pick and shell the crop with minimum damage — an investment beyond the capacity of an individual grower.

Below: Watercress thrives in beds of flowing water.

[illegible]

[illegible] contract [illegible] crops to be grown [illegible] customer can check [illegible] from seedbed preparation to harvest. Many companies even dictate the [illegible] management of the crop. They also provide the materials and specialised machinery essential for consistent large-scale production. In many cases the big processors rent land from an arable farmer for the season and do the whole job themselves. The advantage is that a field previously under wheat or barley, for example, is free of problems specific to the vegetable crop, and at the expiry of the contract the land is generally in better condition for the arable farmer. By taking advantage of this system he is able to concentrate on the cereals for which he is best equipped, without incurring the risk of disease build-up that is so often associated with continuous cropping.

Pick-your-own In contrast to the high

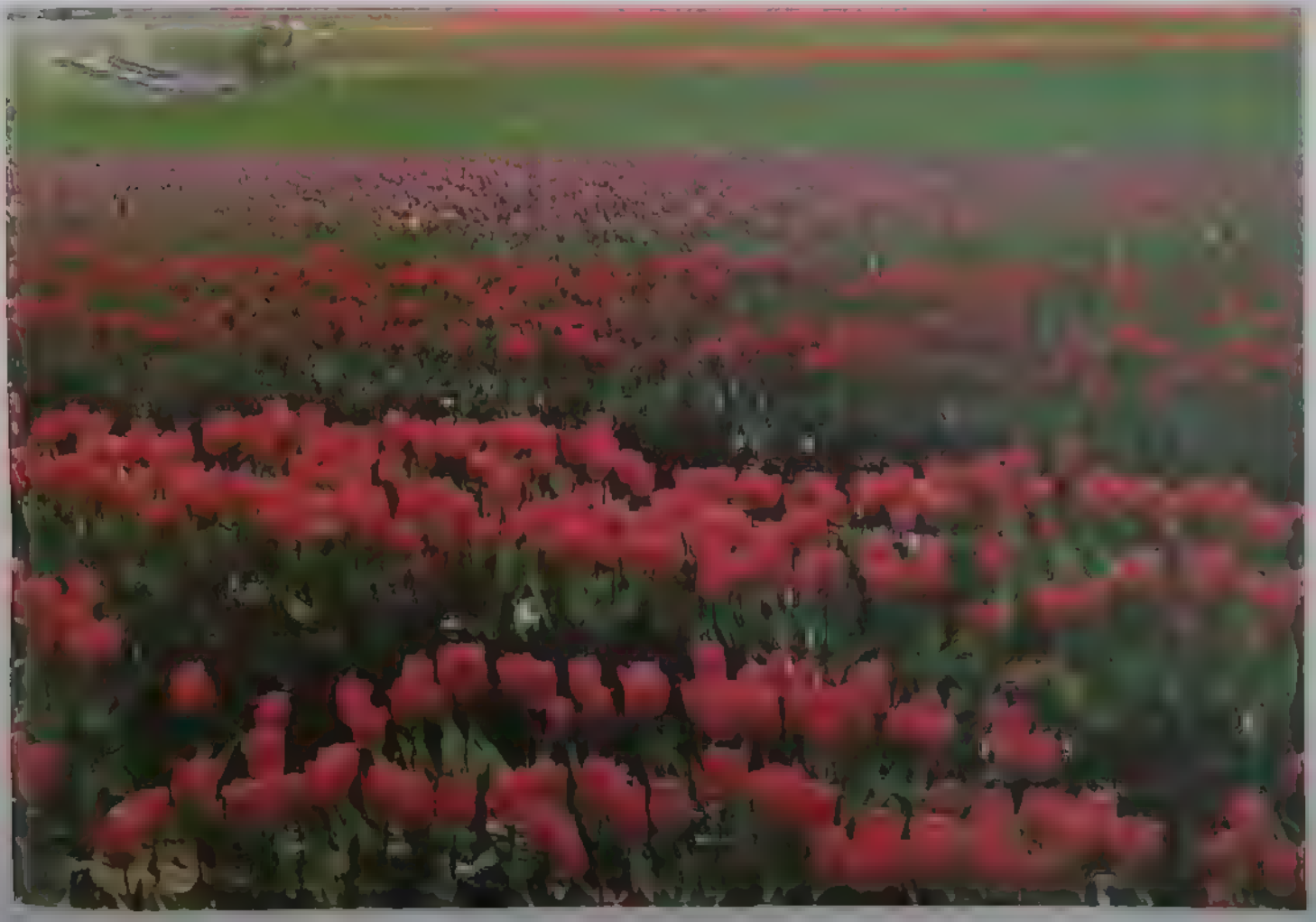
technology of the big contract is the current interest in pick-your-own farming where conventional harvesting is unnecessary, so avoiding the expense of hiring labour or specialised machinery. The waste of eaten overlooked or rejected produce is easily outweighed by these savings The problem is unpredictability: the crop may be ripe, but if there are no customers due to bad weather poor advertising, or even a road closed for the weekend, it will rot on the stem. Despite this pick-your-own is increasingly popular as a business and an entertaining way to buy food It has led to a revival of small-scale fruit and vegetable growing throughout the country, with the emphasis on such crops as strawberries, raspberries and corn-on-the-cob which are normally expensive to harvest and difficult to package. Organic husbandry enthusiasts find the system an excellent way to advertise their activities, while avoiding direct competition with the glossier, cheaper products of agrochemistry

The result is a gratifying exception to the general trend towards larger and larger units While small farms everywhere are being amalgamated into big farms, many small fruit and vegetable growers have preserved their identity by selling their produce direct to an appreciative public. It is a precarious living, subject to changing fashion, but that is one of the hazards of catering for the most demanding and fickle of customers

Above: Giant fen globe onions which, as their name suggests, grow particularly well in the Fens

Below: In spring the flat fenlands around Spalding in Lincolnshire are lit up by the flowers of tulip and narcissus The bulbs are grown for sale to gardeners and nurserymen, and to produce flowers for cutting The fertile fenland silts are ideal for the large-scale mechanised production that is favoured today

Flowers and bulbs This industry began around Spalding in the 19th century. Much of the flower crop is forced under glass for sale early in the season when prices are high. By the time the outdoor plants flower the market price for cut blooms is low, and field crops grown for their bulbs are often picked before the flowering process has taken too much out of the bulb. The blooms are simply discarded, for their market value does not justify the packing and transport costs. The price rises again by the end of the season, to the advantage of growers in north-east Scotland Bulbs are also grown in Kent, the west country, the Isles of Scilly and Jersey where they bloom early in the mild climate



HOOK-TIPS AND LUTESTRINGS

Adult hook-tip and lutestring moths are delicate and pretty, unlike the caterpillars, some of which are very ugly, being covered in wart-like knobbles.

Hook-tip moths belong to the family Drepanidae and, as their common English name suggests, they are distinguished by conspicuous hooks at the tips of their forewings. Six species occur in Britain, five of them obviously hook-tips, while one–the Chinese character–has rounded wing-tips

Lutestring moths are so-named because of the rather fine vertical lines on the forewings of some species. (It must be admitted, however, that the resemblance to real lutestrings is rather fanciful.) They belong to the Thyatiridae, a compact and distinct family, similar in many ways to the moth family Noctuidae

Pebble hook-tip The pebble hook-tip is characterised by the pebbling pattern on its forewings and, to some extent, its hindwings It inhabits birch woods but is also found in gardens and parks, provided there are birches on which the caterpillars can feed. By day the adults sit on the underside of leaves, but they will take a short flight if disturbed–which often ends in disaster, the moths being snatched from the air by a watchful sparrow

Pebble hook-tips produce two broods each year, one in May and the other in August, so the caterpillars can be found in June and July and in September and October. The young caterpillars are quite dark and live on the undersides of leaves, the edges of which are turned inwards and held together by threads of spun silk. As the caterpillars grow older they become lighter in colour so that when fully grown they are green with a brownish back and a yellow head marked with black. One of their most obvious features is the wart-like humps on their backs with hairs protruding from them.

More warty caterpillars The scalloped hook-tip was given its odd English name (which refers to the scalloped edge of its forewings) in 1775 by the entomologist, Moses Harris. Pale or greyish-brown with two almost vertical lines on each forewing, it is another species associated with birch.

There are two generations a year, one in May and June and the other in August. Caterpillars occur in June and July and again in late August and September, when they are found on the uppersides of birch leaves, especially in areas where the soil is acidic They are pale brown with darker markings, and also have warts on their backs

Altogether more richly coloured is the oak hook-tip: an overall brown moth with the wings crossed by two pale wavy lines. The typical warty hook-tip caterpillar is brownish and easy to identify as it is the only British hook-tip to feed on oak. It is a common species found in many parts of the country.

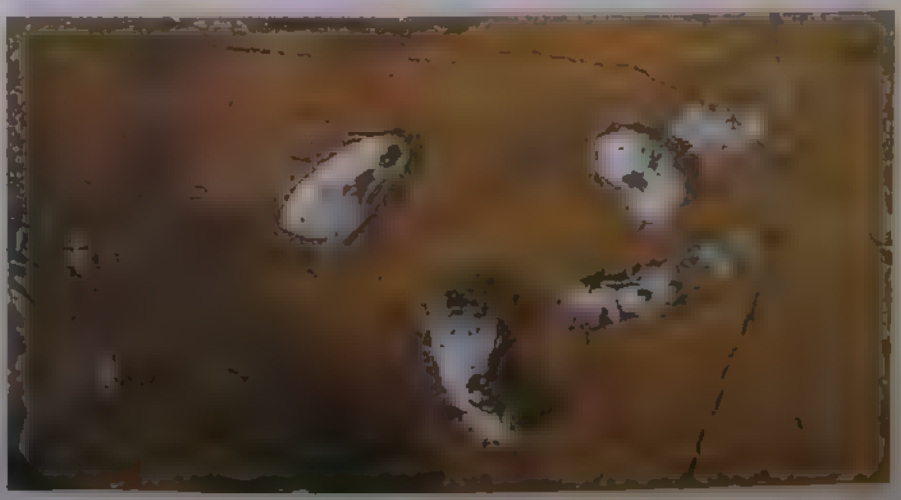
Bird-dropping mimic Another hook-tip, the Chinese character, is supposedly named because of its forewing markings, although the resemblance is not that obvious. One thing is certain, however; the adult bears an uncanny resemblance to bird-droppings–part of its camouflage technique

This species is active at dusk in May and June and again in late July and August. By day it sits around on leaves, and if disturbed falls to the ground. The reddish-brown caterpillars have a pointed rear end and are unmistakably of the hook-tip type–warty.

Above: The pebble hook-tip (*Drepana falcataria*) has a pebbled pattern on its forewings, and to some extent its hindwings as well Notice the hooked wing-tips a feature which enables you to recognise all members of the family Drepanidae, apart from the Chinese character

Right: The figure of eighty moth (*Tethea ocularis*), so-called because of the whitish '80' markings in the middle of its forewings, is a lutestring found commonly in gardens

Below: A Chinese character (*Cilix glaucata*). The moth's extraordinary resemblance to bird-droppings–also in the picture–is an attempt to conceal itself from birds



They feed on the flowers of blackthorn in June and July and late autumn Chinese characters are common in the south but become progressively scarcer in the north

Delicate lutestrings The most striking and certainly the prettiest lutestring is the peach blossom, each of its olive forewings being decorated with five pink 'peach petals

Peach blossom caterpillars are reddish brown in colour and distinctly ridged along their backs, they feed on bramble leaves from July until September. Adults occur in early summer but are rarely seen except at bright lights, to which the males in particular are attracted. The peach blossom is a fairly common woodland species, but also occasionally occurs in suburban and town gardens in various parts of the country

Garden dwellers The common town species in the lutestring family is the buff arches, another pretty moth which has forewings delicately patterned in grey, white and buff, with an overall silvery sheen. At night the buff arches visits flowers for their nectar and the sugary aphid honeydew, but by day it is hardly ever seen. The brown caterpillar has a black line running along the back and is another bramble-leaf eater; it occurs in August and September. The species is common in the south, but scarcer in the north, and is rarely recorded in Scotland.

Another garden lutestring is the figure of eighty, identified by the whitish '80' markings on its forewings. Essentially a southern species, the moth flies in May and June but is rarely seen by day–it favours a nocturnal life and is commonly attracted by bright lights. The yellow-grey caterpillar is about in July and August and is also nocturnal, feeding on poplar leaves; during the day it remains hidden in a curled-up leaf.

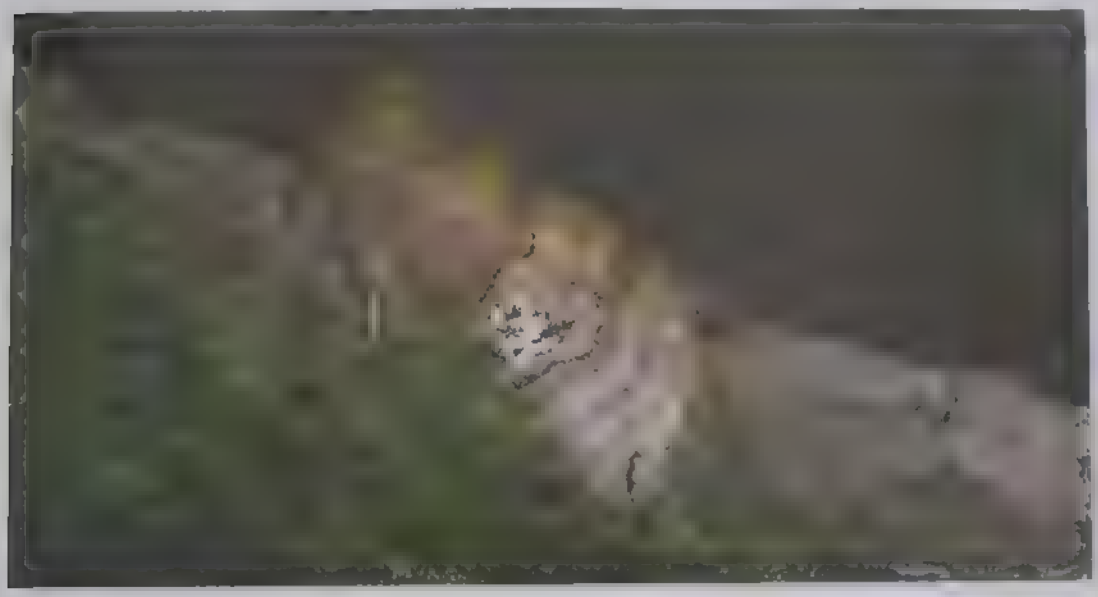
The two remaining lutestrings are the poplar lutestring and the yellow-horned lutestring. Neither species occurs in gardens though, and so consequently they are seen less often.

Adults and caterpillars

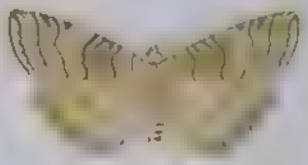
Pebble hook-tip caterpillars can be found from June to July and August to September

Scalloped hook-tip

Oak hook-tip
Drepana d. harpa



Buff arches
Habrosyne pyritoides



Poplar lutestring
(Tethea or)

Yellow-horned lutestring
(Achlya flavicornis)

Peach blossom caterpillars can be seen feeding on bramble between July and September

Moth with petals

The peach blossom moth (*Thyatira batis*) is undoubtedly one of the most attractive lutestrings The scattered pink peach blossom petal-like markings on its forewings are a special means of camouflage, which simply makes the individual look quite unlike a moth Insect-eating birds will not peck at, or explore, what looks like fallen peach petals any more than they would be interested in the Chinese character moth which bears such a close resemblance to bird-droppings and therefore seems most unpalatable

STEEP HOLM ISLAND

Lying mid-way between the English and Welsh coasts, the small island of Steep Holm has developed an exotic ecology which includes giant blue slow-worms and wild peonies.

The island of Steep Holm lies 8km (5 miles) out from the seaside resort of Weston-super-Mare in the Bristol Channel. Scheduled as a *Site of Special Scientific Interest* (SSSI), it was acquired as a nature reserve in 1976 in memory of the author, broadcaster and naturalist, Kenneth Allsop, who died in 1973.

Geologically, Steep Holm is an outlier of the Mendips and thus, despite being only 1km (½ mile) long and ½km (¼ mile) wide, dramatic cliffs of Carboniferous limestone, rising to a height of 75m (250ft), ring the island. Surmounting the cliffs is a 20ha (50 acre) plateau which, for much of the year, is covered by a surprisingly lush jungle of vegetation. Nurtured by Steep Holm's own micro-climate, which is warmer and drier than that of the mainland, growth is further assisted by the guano from thousands of sea-birds

With its commanding position over the Bristol Channel, Steep Holm has, in the past, attracted Viking raiders, Augustinian monks, pirates, smugglers and, more recently, the military. This unusual history of human occupation is evident from the ruined buildings and coastal batteries which litter the island and in the exotic species of plants and animals which now complement the native flora and fauna

Today, Steep Holm only attracts naturalists and tourists, who take the regular Saturday ferry across from Weston-super-

Above. A view of Steep Holm from the south-west showing Rudder Rock and the searchlight post (far left)

Below: Steep Holm's famous wild peonies, almost certainly introduced by monks in the 12th century, bear single, scented, deep pink blooms in early May and large handsome seed pods in September. This wild species originates from southern Europe and is found nowhere else in the British Isles

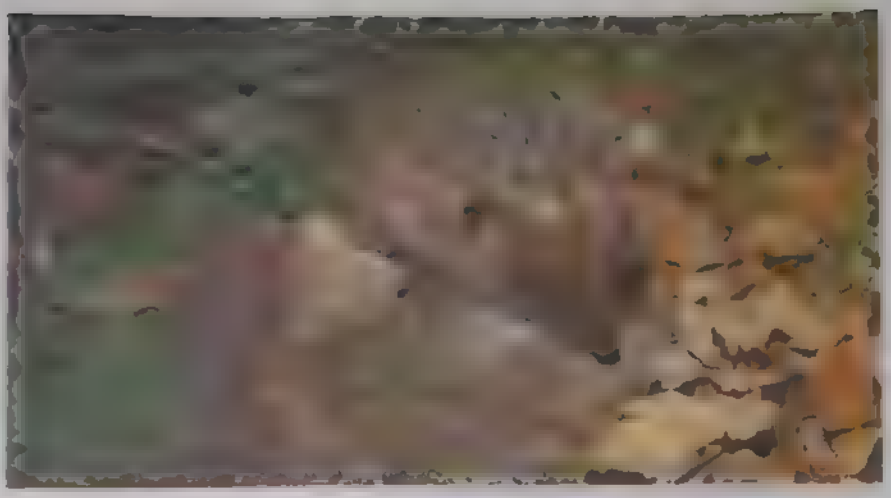
Mare to spend a day, weekend or week on the island between the months of April and November. Visitors are generally landed on the small beach at the eastern end of the island, which provides the start to a well-marked nature-trail

Following the nature-trail From the beach steps lead up to a cliff-path which climbs northwards past the ruins of an inn which, in its Victorian heyday, briefly claimed exemption from licencing laws. Flanking the path, a variety of plants more usually encountered on old walls in West Country lanes grow here in their natural situations. The most conspicuous of these is red valerian whose bright red (and sometimes white) flowers favour the sunnier places from May onwards. A familiar plant of hedgerows, the cuckoo-pint abounds among the tangle of ivy below the path, but it is found in greatest profusion around the ruins of Cliff Cottage. Its bright coral-red berries are poisonous

Beyond Cliff Cottage, the nature-trail doubles back along the track of an incline railway, built in 1941 to transport ammunition. At one time many of the island's wild peonies grew in this area, but their place has been taken by a thicket of sycamore which shows a remarkable tolerance of salt-spray

Before the summit of the railtrack is reached, a path diverts to the rugged beauty of Tower Rock from which, looking down and across the cliffside towards South Landing, a considerable quantity of rock samphire can be seen clothing the rock. The thick grey leaves of this bushy, yellow-flowered umbellifer were once pickled and eaten by islanders. South Landing itself is reached via a steep but attractive path which follows the route of another incline railway a short distance past Garden Battery. The stone-built jetty and hoist platform provide an alternative landing to the beach, the well-preserved limekiln having been used to provide mortar for the Victorian buildings and batteries. Grey seals from the Welsh colonies are sometimes seen here. If the visitor is patient and avoids sudden noises or movements, they will frequently come close out of sheer curiosity. It is down in the splash zone at this point that the rare wild leek grows. A robust plant with long, greyish-green, strap-like leaves, its round purplish head of flowers appears in July or August. Possibly introduced by the 12th century monks, it is believed that the Steep Holm colony represents the only genetically pure wild stock of the cultivated species. Even the commoner plants on Steep Holm display exaggerated features. The common sea-lavender, for instance, which grows nearby, is distinctly larger than its mainland counterpart. This larger than mainland life quality applies to many of Steep Holm's animals, too –snails, slow-worms and even woodlice are all larger on the island.

Steep Holm Centre Returning to the summit, the trail leads on to the Victorian



Above: Hedgehogs, a fairly recent introduction to the island, can often be seen round and about Steep Holm Centre

Right. The curious wall pennywort is to be found along the route of the nature trail leading up the cliff path from the landing stage. It is a plant that prefers damp, shady crevices, sending up tall spikes of greenish tubular flowers from a base of round fleshy leaves that are characterised by a small central dimple

Below: Steep Holm harbours an amazing population of about 5000 purse web spiders (*Atypus affinis*), which lie in wait under stones, concealed within their silken sheaths or 'purses'. Insects unfortunate enough to alight on the sheaths are stabbed with poison from within before being dragged in to be consumed at the spider's leisure

Left Great black-backed gulls at their nest site at Tower Rock on Steep Holm

Right The Slow Worm is the island's only reptile and it inhabits burrows beneath the loose scree, although it may be encountered all over the island especially under pieces of rusting World War II corrugated iron illustrating the phenomenon of island evolution'. the slow worms of Steep Holm are much larger than those on the mainland (they have been claimed at up to 1m 3ft in length, although the largest specimen caught by a scientist was half this, at 48cm/19in; this is still long enough, however, to qualify as the second longest ever found in the British Isles) They are typically blue in colour, with shades ranging from pale sky blue to a deep ultramarine

barracks which have been converted into the Steep Holm Centre, providing dormitory accommodation for those staying on the island as well as offering shelter, toilets, snacks and refreshments to the day visitor The island has its own natural supply of water which would appear to be fed, in part at least, from the mainland, fresh water having been observed to bubble up off the beach following prolonged rains.

Immediately to the west of the Centre, a path leaves the trail to cross the breadth of the island. Not far from here is to be found the wild peony, for which the island is famous. Another probable introduction is the caper spurge which grows nearby. Continuing west along the nature-trail, the visitor soon enters a dense scrub of wild privet and elder, which is home to the small Chinese muntjac deer, a pair of which were presented to the Kenneth Allsop Trust in 1977. Feeding on bramble leaves and privet berries, the muntjac have prospered yet are more likely to be heard 'barking' than to be seen

Above. Along the paths of the island you may well encounter a poisonous duo of plants–the evil-smelling henbane (shown here) whose sticky foliage supports creamy white flowers, and hemlock with its purple-blotched stem. Avoid touching these plants–both are extremely poisonous and both have a most unpleasant foetid smell. Henbane is in flower from May to September and hemlock from June to August
Apart from the danger of picking these poisonous plants, visitors to the island are warned not to try rock climbing since the cliffs are very unstable, and also not to swim in the sea because of the very powerful currents.

Meadow of alexanders Across the centre of the island an even more dense jungle of alexanders dominates the spring landscape By mid-summer, nettles begin to take over the leafscape of the 'alexanders meadow', only to be ousted in their turn by the lighter green of annual mercury in October

The alexanders meadow is a favoured haunt of the rabbit, which finds protection from the voracious gulls in the dense cover Introduced into Britain by the Normans rabbits were first released on to islands and promontories from which it was difficult to escape. It is significant that one of the earliest documented rabbit warrens in Norman Britain was on Brean Down, the nearest point of the mainland to Steep Holm and a mere 8km (5 miles) away. What is so interesting about Steep Holm's rabbits is that since their introduction to the island in the late 12th or early 13th century, they have become noticeably and uniquely reddish in colour, illustrating just how rapidly evolutionary change can come about in an island context

Steep Holm's other mammal, the hedgehog, also makes use of the protection afforded by the alexanders and the scrub. Likely to be a recent introduction, hedgehogs are frequently seen around the Steep Holm Centre

Up to 2000 pairs of herring gulls take over the west end of the island between Split Rock and Rudder Rock in early summer. An average of three eggs are laid from the end of April onwards and these can vary in colour from olive to brown but with the characteristic black-brown blotches. The nest is usually lined with strips of alexanders, together with any available grass, both parents undertaking the incubation. After about 28 days, hatching occurs but the chicks remain close to the nest for up to eight weeks, by which time they are fledged. However, from a clutch of three, only one immature bird is likely to leave the island alive. In addition, some 400 pairs of lesser black-backed gulls add to the noisy spectacle, preferring the more open areas and even nesting in trees. Somehow the bright pink clumps of thrift manage to survive the gulls.

while lower down the cliffs a forest of bright purple testifies to the presence of the tree mallow and a splash of yellow to the biting stonecrop. Before leaving the west end of the island, the fine view of the Exmoor and Quantocks coastline, best obtained from Split Rock, should not be missed.

The northern coast The trail now returns along the more exposed northern coast. Close to the foot of sheer cliffs, beneath Summit Battery, about 70 pairs of cormorants have their nests. They can be seen flying back and forth on fishing expeditions. A flight of 208 steps leads down to a 1941 searchlight post, now used by birdwatchers. From here you can look out towards the lighthouse on the smaller island of Flat Holm. Other Steep Holm birds which like to nest within the sound of the sea include the great black-backed gull, stock dove, rock pipit, shelduck and the oystercatcher, while visiting species include the raven and peregrine falcon.

Plant life along the north of the island is less varied, with bramble and nettles dominating the plateau. Common scurvy-grass favours the drier slopes while the buck's-horn plantain, which grows from cracks in the cliff wall, boasts a sub-species that is unique to the island of Steep Holm.

Passing Laboratory Battery, where the movements of migrating birds and the distribution of the island's large banded snails are the subject of study, the trail leads on to Tombstone Battery, above which an exceptional view can be had of the entire Bristol Channel -shattering, if only briefly, the illusion of Steep Holm's isolation.

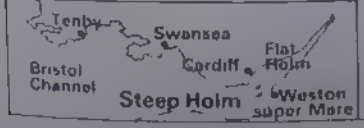
Plunging once more into elder scrub, our circuit of the island ends at the ruined 12th century priory, to which so much of the island's unusual wildlife owes its origin, the processes of nature having ensured that the activities of these long distant monks live on in the ecology of this island of curiosities.

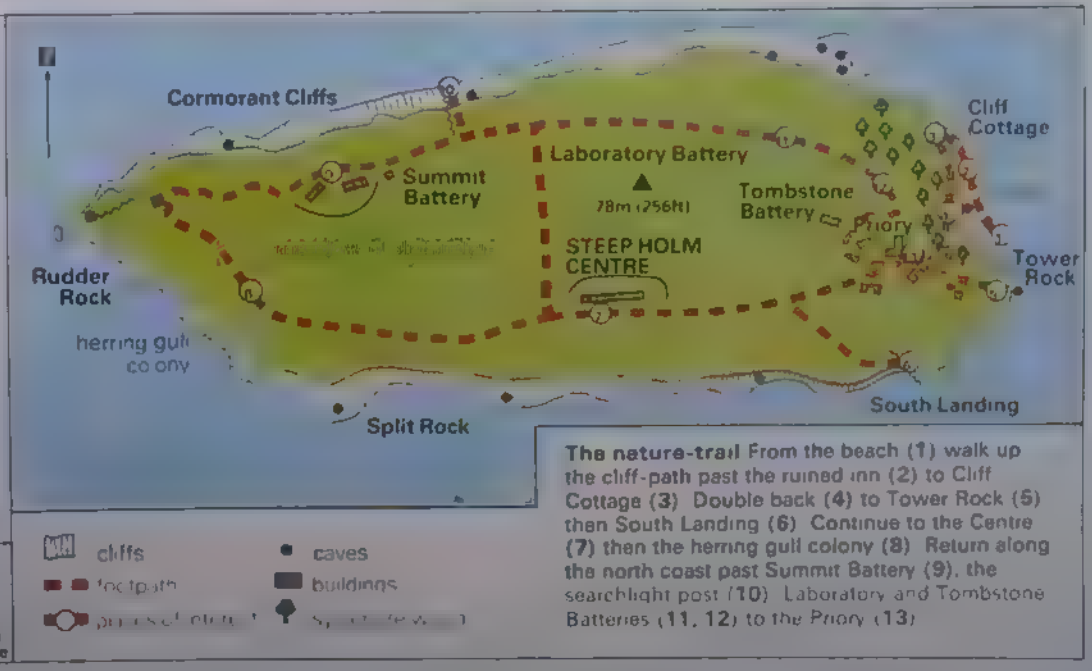
Above Banded snails (*Cepea nemoralis*) are the subject of a special study being made on Steep Holm

Right Alexanders just coming into bloom. This tall, leafy, green umbellifer was grown as a pot-herb by the monks of the island and has subsequently benefited from the many thousands of gulls whose guano provides an ideal fertiliser. One of the sights of the island in spring is the 'meadow of alexanders' which covers more than 8 hectares (20 acres) of ground with a lush green carpet

Visiting Steep Holm

The island can be visited from the beginning of April to the end of October by means of boat trips from Weston-super-Mare. These are day trips. Individuals or groups may also stay on the island for a weekend or even a week. All enquiries about prices and bookings should be made to: The Kenneth Allsop Memorial Trust, Knock-na-cre, Milbourne Port, Sherborne, Dorset DT9 5HJ, tel 0963 32583





The nature-trail From the beach (1) walk up the cliff-path past the ruined inn (2) to Cliff Cottage (3). Double back (4) to Tower Rock (5) then South Landing (6). Continue to the Centre (7) then the herring gull colony (8). Return along the north coast past Summit Battery (9), the searchlight post (10). Laboratory and Tombstone Batteries (11, 12) to the Priory (13).

MOST SUCCESSFUL BIRD SPECIES

Some bird species are on the edge of their range in Britain and Ireland, while others are so well suited to conditions here that their populations number in the millions. Here we look at some of the ways which can be used to measure 'success'.

Opposite page: The Brent goose deserves mention for persistence in the face of adversity. Fifty years ago, its main food plant, eel-grass, nearly died out, and the geese faced starvation Survivors turned to winter wheat as an alternative food, and so the species held on until the eel-grass became plentiful once more

Above right: The wren is our choice of champion for persistence in the face of adversity In any really severe winter, millions of wrens die of starvation or heat loss; but within two or three years they are back to normal numbers–around ten million pairs

Below: The peregrine has survived DDT poisoning, egg collecting and capture for sale to falconers

The choice of a 'most successful bird species', even if restricted to birds of Britain and Ireland, is one of great complexity as so many birds are judged to be successful, using a variety of different criteria. Do sheer numbers, for example, carry more weight than the ability to survive, albeit as a rarity, under adverse conditions? Similarly, is the ability to exploit new habitats and food sources a greater measure of success, or the capacity to take advantage of man's presence? We have adopted the solution of awarding a number of 'prizes', using different standards to award each one. Then, from among these 'class champions', we select a 'supreme champion' or most successful species of all

Birds as a group are among the most mobile, versatile and adaptable of animals, and this makes the judge's task no easier Many, for example, exploit a variety of habitats succeeding with difficulty in some and with ease in others. Migrant species, such as waders, that breed far to the north inside the Arctic Circle, probably endure no more than average difficulty away from their breeding grounds, but need to be in perfect physical condition if they are to make a success of the all-too-brief breeding season, with its treacherous weather. In between their two habitats they give another astounding demonstration of their abilities: a migratory journey of several thousand miles, some of it across the sea, and perhaps some over equally inhospitable deserts. This is a magnificent achievement in terms of physique and navigation, but one performed by millions of birds twice annually.

Most successful migrant Many of the migrants which use Britain and Ireland as either their breeding or their wintering area perform roughly similar journeys. The title contenders here are likely to come from among those birds which pass through these islands on their way to even more distant localities. Though few breed here, the red-necked phalarope is one contender under this heading. Wintering in tropical Africa, often at sea, this tiny wader breeds well north into the Arctic tundra. As part of its stratagem for success, the normal roles of male and female are reversed: the female is larger and brighter, and takes the dominant role. Having chosen a mate, she lays, and then leaves the male to incubate the eggs and raise the brood single-handed, while she procures a second mate and repeats the process, thereby increasing the chances of the survival of the species.

At least as remarkable, though for different reasons, is the wheatear. One race of this small member of the chat family breeds in Greenland, wintering well south in Africa. Some migrate via Iceland and Britain, but others, heading south, make their first landfall in Spain–a prodigious oceanic journey (including a crossing of the notorious Bay of Biscay) for such a small land bird

These considered, perhaps the title should

after all go to a bird that does breed in considerable numbers in northern Britain and Ireland, the Arctic tern. No other migrant travels so far each year, and none sees so much daylight, for the Arctic tern leaves the 'perpetual day' of the Northern Hemisphere summer for the equivalent in the Southern Hemisphere, where it fishes off the ice in the Antarctic Ocean.

Persistence in adversity This is an altogether different category, but one no less varied. Contenders naturally include small resident birds such as the wren; often noisily abundant throughout the summer countryside, the wren's small size can be its undoing in periods of really severe weather. Days for feeding are short, and the nights which have to be endured are long, during the winter. An additional hardship occurs when frost or snow conceals food. Indeed, if ultra-low temperatures cause energy (in terms of stored fat) to be burnt up (in the process of keeping warm) faster than it can be gathered, then catastrophe may hit the wren.

Opposite right: Novelty is one of the criteria used in judging the class of birds for ability to cope with urbanisation. The tawny owl is in a position to welcome urban spread, as this always brings sparrows, to which the owl has become partial. Brown rats, another urban species, do not escape its notice either. Invertebrate foods, particularly earthworms, form a significant part of the owl's diet, and therefore it can hunt successfully on school playing fields at night.

Below: The chaffinch—in winter, visiting birds from the Continent swell its population, making it our most numerous species.

In particularly harsh years, mortality can be around 70% or 80%. But the wren shows a remarkable ability to bounce back from such [illegible] with considerable speed, as [illegible] two or three years elapse before numbers are restored. This is the wren's claim to the title: in view of its large and successful population, we place it at the he[illegible]

A survey of the peregrine falcon, carried out because pigeon fanciers thought that peregrines were taking too many of their racing birds, showed a calamitous decline between the 1930s and the early 1950s. Some peregrines were shot during the wartime years because they preyed on pigeons carrying military messages, but the real culprit was discovered after some rather elegant research had been carried out, investigating eggshell thicknesses.

The causes of breeding failure were traced to an excessive frailty of the eggshells, and the cause of this was DDT. This was a wartime product developed to control human tick and louse infestations. Post war, it became a cheap, effective agricultural pesticide—but one of long environmental persistence. It accumulated along 'food chains' and poisoned the predators at their summit, including the peregrine. Ultimately the DDT was withdrawn, voluntarily, from agrochemical use, and peregrine numbers began to recover.

Today, the main threats are egg collectors and falconers seeking this noblest of the falcons, with its thrilling 'stoop' at prey, to keep in captivity. Despite the robbery of dozens of eyries each year—quite illegally—the peregrine is tolerating this additional man-made burden and holding its own.

The story of the red kite is broadly similar. The tiny population—a few dozen birds—in the mid-Wales oakwoods has held on against threats from poison baits. These are often laid for crows or foxes, but laid ignoring the fact that the kite too is a carrion feeder. Egg collectors, too, are a serious hazard. In spite of these, and with the help of bird protection organisations such as the RSPB, the red kite has in the last few years been more productive as a breeding bird than for decades.

Last in this category is the Brent goose. When its main food plant, the marine eelgrass *Zostera*, was almost obliterated by disease, Brent goose numbers crashed. Then the geese changed their diet: they began to eat some seaweeds, and to fly inland to feed on winter wheat shoots. This helped to stave off disaster, as did a series of good summers on its Arctic breeding grounds. Here, the normally savage weather ameliorated for several successive seasons, and fledging success was high. *Zostera*, too, has staged a comeback, and Brent goose numbers are now such that some farmers consider them a pest!

Coping unexpectedly with man Here the challengers have been selected on the basis of novelty: the more routine cohabitants with man are considered in another category.

Urban areas contain numerous rodents–rats and house mice in particular–and both the tawny owl and the kestrel feed on these and on the abundance of house sparrows. Gardens, parks and playing fields are also home to an array of smaller animals, and perhaps in contrast to popular belief, both these predators, with their astonishing powers of sight and hearing, do feed for much of the time on creatures as small as beetles and worms

But paramount in this category must be the magpie. This alert, cautious member of the crow family has turned its rural egg-stealing way of life to good effect, following urban milkmen on their early morning rounds Door-step deliveries of milk bottles are often accompanied by boxes of chicken eggs, and the magpies break open these cartons, consuming the contents of the eggs within.

Exploiting new environments Here pride of place must go to the little ringed plover, colloquially 'LRP' to birdwatchers. It was

Right: The figures used in the population chart are an interpretation of data from the BTO *Atlas of Breeding Birds in Britain and Ireland* This information was collected during the years 1968-72, and is the latest across-the-board count of birds in the two countries. In a few cases, it has unavoidably ceased to be true. The main change is the collared dove, which by the early 1980s had stabilised at a little over 100,000, after nearly 50 years of dynamic growth

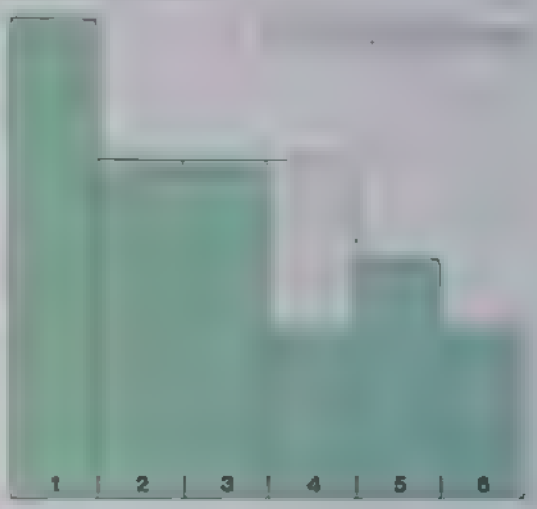
Below: The collared dove therefore wins the prize for the most promising newcomer', as well as the supreme championship

Breeding bird populations

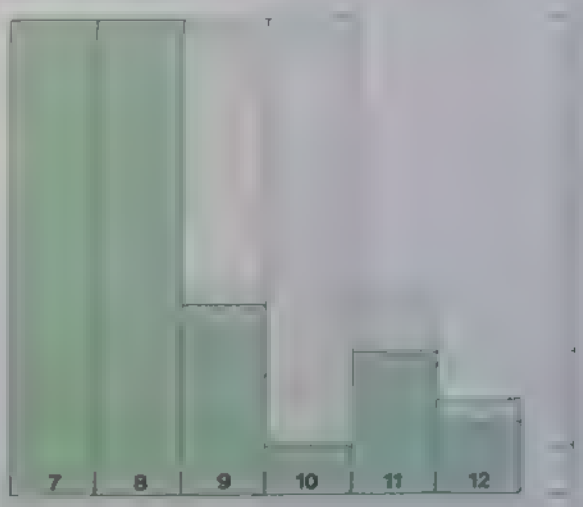
[illegible] in pairs [illegible]

[illegible] 1 [illegible] 2 chaffinch 3 [illegible] 4 [illegible] 5 [illegible] 6 starling 7 kestrel 8 rock dove [illegible] pigeon (combined) 9 curlew 10 [illegible] owl, 11 collared dove 12 sparrowhawk 13 little ringed plover, 14 peregrine 15 golden eagle, 16 black-throated diver 17 black redstart, 18 red kite

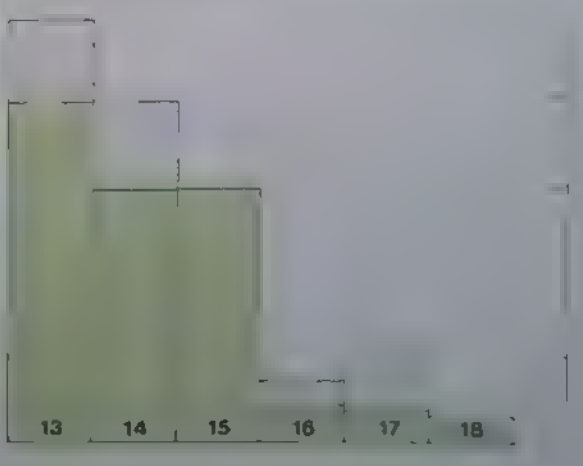
High range–millions



Middle range–thousands



Low range–hundreds



almost unknown in Britain before the 1930s, but post-war building created new reservoirs and mineral extraction pits–for sand, ballast, clay and chalk–and these provided a novel environment that this migrant wader was quick to exploit in the south and east. The breeding population remains quite small, but the vast majority of LRP pairs nest on man-made sites; they seem to be quite untroubled by the constant comings and goings of heavy machinery nearby

Most successful exploiter of man The challengers for this title are more predictable, with the house sparrow and starling leading the field. Both flourish in association with man, and the house sparrow rarely ventures far from man's activities or buildings. Some inner-city populations live a life with almost no 'outdoor' aspects and eat only man-provided food. An example of this is the sparrow population in a large main-line railway station. The starling, more mobile, more garrulous and more quarrelsome, is perhaps also wider-ranging in its exploitation, especially in the range of farmland that it can successfully occupy. Grassland, orchards and cattle feeding areas all satisfy the starling's food requirements, and the species has established itself successfully as a pest (so effective is its exploitation!) in many parts of the world where it was thoughtlessly introduced by early colonists.

Most successful newcomer Although in the last few decades several birds have returned after a temporary absence to establish greater or lesser 'toe-holds' as breeding birds in Britain, genuinely 'new' newcomers are less numerous. Cetti's warbler is one true newcomer, but there is only one serious contender for this particular title. The collared dove was unknown in Britain and Ireland before the mid-1950s, but then the first few pairs of collared doves settled in Norfolk and Kent Naturalists and ornithologists protected these few pairs with the utmost secrecy, but their efforts at conservation were overtaken by events. Such was the strength of the tide that swept the collared dove westwards across Europe from its Asian homeland that within two decades all of Britain and Ireland had been conquered and colonized, and in many areas collared doves had reached such numbers as to be considered a pest on poultry farms and in grain storage silos. Now their dry call and monotonous coo-*coo*-coo song is to be heard year-round almost everywhere

'Supreme Champion' A difficult choice with such a range of avian talents to choose from. Should emphasis be given to sheer numbers, or to resilience, or to migratory prowess, or adaptability? Only one of these birds would qualify for a reasonably good score under each heading, and so the 'supreme' title should logically fall to the phenomenally successful collared dove

Above: The magpie wins the prize for originality in coping with urbanisation

Below: Starlings are great exploiters of man: here a group of them are feeding on slaughter-house offal at a rubbish tip

Below left: The little ringed plover has established a British population of some 400 pairs. It has done so by spreading to a newly made habitat–mineral extraction pits

THE VARIED YEAR OF THE VET

John Fletcher, a vet and deer farmer in Scotland, describes the challenges and problems encountered throughout the year. The more sophisticated breeding techniques have become, the more there is to go wrong, so for him there is never a dull moment.

As I drove quickly down the empty black country lanes I could glimpse the moon occasionally between scudding clouds and snow flurries. It was January and not the season normally associated with lambing in the popular picture of lambs skipping in the spring sun. I suppose we are all influenced by the seasons, and for the country veterinary surgeon the changing year intrudes into his work every single day. The large animal practitioner–the vet who deals with farm animals rather than pets–thinks of the summer as the time when his patients are grazing while the winter, especially in northern Britain, is associated with artificial feeding of hay, barley, potatoes and turnips.

Above A farm at Watendlath in Cumbria in the Lake District Although a vet's job takes him to beautiful places, there are many frustrations in getting there, such as coping with bad weather and holiday traffic.

Right· A vet checks the health ofa pig and takes a blood sample. Like other farm stock, pigs also have t be vaccinated against harmful bacteria.

A seasonal existence For the animals themselves the seasons are a matter of life and death. In a species such as sheep it is vital that the period of lactation coincides with the period of maximum food availability, since the production of milk and the suckling of young is a much greater drain on the lactating female's reserves than the growth of an embryo is a drain on the pregnant mother. For this reason all British grazing species, such as deer, rabbits and hares, produce their young in the spring because, in the Northern Hemisphere, outside the tropical regions, grass growth is at its best in May and June.

As the time interval between conception and birth (gestation length) is determined by

Above Sheep have been rounded up for a multi-vaccination against lethal bacteria. This is particularly important just before lambing starts so that the protection is passed on to the newborn lambs via the mother's colostrum (the first milk produced by a mammal after giving birth). Vaccinations continue to be given regularly

and lasts at all [illegible]

As I turned into the farm yard I consoled myself with the wry thought that although this disregard of seasons was only one example of how the manipulation of farm animals provokes disease, it nevertheless provides the mainstay of the rural vet's business

The man who came out to greet me was exhausted; only three or four hours of sleep in each of the last five nights was taking its toll Nevertheless he was cheerful. Three weeks ago the situation of his sheep flock had been desperate. Several ewes had died; 'twin lamb disease', an apt name for a sickness which kills many high producing sheep, had appeared

Selected by man to produce twins or triplets and then lambed at unnatural times of the year, the modern ewe, like a racing car, requires constant careful 'tuning'. The vet's job is to keep the 'car' on the road. The recent outbreak of twin lamb disease had been controlled by feeding glucose solution to the ewes, to provide rapid energy, and by improving their food. I had warned my client that although the ewes were now looking healthy enough he should expect some stillbirths, but so far he had got away with a surprisingly successful lambing. His immediate realisation that something had been wrong had probably saved the day–hence his smiling welcome now

He led the way into the barn, talking as he went. 'I thought she was starting to lamb about six this evening but she didn't seem to be making much headway so I had a feel in her. Couldn't seem to get my hand in and now she's stopped straining.' There she lay on the straw. A glance at her teeth told me that she was no chicken. He had soap, water and towels ready and I gently eased my hand into the warm passage. Certainly she was tight and I had to spend many minutes gradually opening up the cervix. Inside was a jumble of legs: each had to be distinguished so that I could be sure of two front legs from the same lamb, and then the head, and finally out came one lamb, and then more easily two more. The last one

the size of the adult of the species, and is thus almost inflexible, it follows that the mating season needs to be timed precisely so that mother and infant can reap the benefits of a suckling period running through the abundance of summer. By measuring the amount of daylight the animals can tell what time of year it is and time their mating accordingly. Unfortunately modern man does not want all his farm animals to produce young at the same time of the year or there would be formidable periods of glut and famine. He therefore works hard to have them calve, lamb, farrow

resisted all attempts at resuscitation, but the others flapped about like newly landed fish and were soon shakily looking for milk. The ewe was slower to rise but by the time I left there seemed a good prospect of her raising the two

Man-made problems As I drove home I wondered how much of the old ewe's problems had been brought about by man's interventions. Yet just as modern man lives a completely unnatural life and remains surprisingly healthy, so modern farming works wonderfully well too. My early work had been with wild deer and I knew how rarely they experience the problems of other modern farmed animals, and yet how miserable the lot of the wild deer can be. Centuries ago that old ewe would have died years before of cold and starvation, or perhaps fallen prey to a wolf, lynx or similar predator, had it not been for the attentions of her hardworking shepherd.

Man has bred cattle to produce colossal quantities of milk, to calve and to grow quickly, at all times of the year. The wilder, more primitive cattle, however, certainly time their mating by reference to the length of daylight so as to ensure a spring calving. They conserve scarce food resources by slowing up their chemistry and growing more slowly during the winter. The diseases which vets struggle against day and night are for the most part foreign to the wild animal. Twin lamb disease, difficult lambings, and a whole host more have occurred in farm animals for many years, often as a direct result of man's selective breeding. On the other hand, wild animals also suffer their own diseases.

Deer farming One of the practice's most interesting clients is someone who had recently started a deer farm. Each year in February and March he buys wild red deer which have been forced by cold and starvation off the highest hills of Scotland to raid turnips from the crofters' fields. It is a simple matter for the crofter to catch these deer and load

Above: A sow suckles her young piglets. Some have probably died, as pigs have an average of 9.4 piglets per litter

Below: This sequence of pictures shows a vet and his assistant who have come to the aid of a cow in difficulties during calving. The vet feels inside her to correct the position of the calf. Then he attaches a rope and he and his assistants pull hard to deliver the calf. Minutes later the cow is licking her offspring

Above: Taking blood to test for brucellosis, now a rare disease in this country. It causes abortion in cattle and undulant fever in man. Cows, such as this Jersey cow (below), are regularly drenched for worms to prevent parasitic diseases

injection to kill all these parasites the deer can be nursed back from the poor tion that results from a Scottish winter experience taught me that wild deer do not have an easy life, and the hard statistic that in the Scottish Highlands over 60% of calves born to wild red deer are likely to die before they are one year old came as no surprise.

them into a lorry for delivery to the farmer in a warmer environment. Inevitably they arrive emaciated and riddled with warbles - the larvae of a fly whose eggs are laid on the legs of deer and migrate through the body to emerge as inch-long white maggots under the skin of the back in the early spring. By careful feeding and perhaps even housing and by giving a

Busy springtime While February, March and April are the months of starvation and 'the hungry gap' in Scotland, in southern England the spring is by then well under way. Lambing is, of course, still a seasonal event as although the early lambs are usually born indoors, for me the essence of spring remains a vision of the vet kneeling by a ewe, groping for the 'golden slippers' of a lamb, early in the morning in the damp new grass, rather than battling in the tumult of an electrically lit lambing shed in January. These golden slippers are soft yellow tips of cartilage borne by the lamb in its mother's womb to protect her from injury as the embryo lamb practices its kicking. They wear off in a few hours after birth. In the British Isles our sheep are mostly of highly prolific breeds and they therefore require quite sophisticated lambing husbandry. Many student vets work an apprenticeship on a farm during lambing and it would be hard to imagine a better training long hours with plenty of opportunity to see normal as well as abnormal births.

Another illness which contributes to the vet's busy spring affects cows. One morning during breakfast the phone rings: 'staggers at Birchwood Farm', my wife calls, and off I rush. 'Staggers' or 'grass staggers' is always an emergency. Some poor farmer awakes one morning after a cold windy night to find one or more of his cattle, which were apparently healthy the night before, lying dead or dying in the spring grass.

Such cases are a consolation to the modern farm vet for he knows that he can actually help most of the cases he sees by giving them an injection of a solution of magnesium.

Often the affected animals are in an exposed field at the top the farm and a long rough track has to be followed. This morning I was bundled into the back of a tractor and bounced along through three or four gates until we finally saw the black and white cow, still alive–but only just. I told the driver to stop as any noise or excitement can precipitate a fit in a cow in this condition. She was lying quietly but had obviously had one or more fits as the ground was torn up and she had froth on her lips. Her heart could be heard pounding away even as I stood a few feet away preparing the injection.

I had little doubt that this was a magnesium deficiency and her reaction as I pushed the needle into her vein confirmed the diagnosis for her eyelids twitched and flickered uncontrollably. The injection is large and long and not without risk but, untreated, this cow

would surely be dead in an hour or two. [illegible] response to the injection was good [illegible] immediate and we were soon able to walk the cow into a crate and drive her [illegible] shelter and warmth of the farm.

Summer problems With summer [illegible] flies, and another disease which [illegible] and costs new but not the [illegible] of mastitis. Spread from cow to cow by flies, the udder is attacked suddenly and dramatically by a bacterium (*Corynebacterium pyogenes*), and in no time the udder swells, blackens, and is partially destroyed. Thanks to modern antibiotics however we can control this disease if we get there in time and modern fly repellants help to prevent its spread.

These fly repellants are not effective enough to allow vets to continue safely with the dehorning of cattle and the castrating of horses during summer. The fear of flies infecting wounds causes us to delay these operations until the autumn; by this time the frosts have killed the insects and there is a backlog of colts to geld and cattle to dehorn.

In the old days horses were gelded as they stood or were pulled down with ropes. A strong man would put a twitch (a loop of string on a stick) round the muzzle and pull it tightly and painfully to distract the horse from the graver procedures going on at his other end. Today drugs are used to make the horse unconscious.

With the coming of winter in northern Britain the farm animals are housed again, and we can only live off our dreams of sunshine and green grass, while outside the wild animals, with their summer's accumulated fat to keep them alive, prepare for the onslaught of their most testing ordeal, the long, cold winter.

Above Treating Blackface sheep to prevent disease.

Below Autumn: the sheep are growing their coats again. It takes experience as well as knowledge to be able to detect diseases beneath the wool.

THE SMALLEST TREES IN BRITAIN

Willows and birches are generally thought of as tall graceful trees; likewise juniper is to most people a large bush. But there are some willows, birches and junipers growing in Britain that are hardly taller than a daisy. These are our dwarf 'trees'.

Most of our dwarf trees belong to one genus, the willows. The smallest of them could easily be missed from a distance of a few yards and, far from providing a perch for birds, would be hard pressed to support a modest-sized insect This minute tree is least willow. It has a long, much-branched underground rhizome which creeps over a large area. From this arise short aerial branches rarely more than 3cm (1in) long, which vary from being upright to lying flat along the ground. Each branch normally bears between two and five thin, toothed, rounded leaves with prominent veins.

In common with other willows, least willow bears catkins. These are borne on short stalks after the leaves appear -usually in June. All willow catkins are aggregations of male or female flowers. In this species the male flowers are much reduced, usually consisting of just two stamens The female catkins are made up of several oval capsules which turn reddish when ripe

Least willow is an alpine species, rarely being found below 600m (2000ft), though it does descend to as low as 100m (300ft) in Sutherland because of the climate of that area It can be found in Wales, Yorkshire, the Lake District and on all suitable Scottish mountains. It occurs on mountain tops and rock ledges where almost nothing else can grow

Big brother Net-leaved or reticulate willow can be regarded as least willow's big brother, though it is not a great deal bigger. This plant is even more attractive than its smaller relative, with leaves that are covered early in the season with long silky hairs. These disappear later on, revealing the prominent net-veining on the undersides of the leaves that give this plant its name. The catkins appear on terminal stalks after the leaves have unfurled

Reticulate willow has a very local distribution in Britain. It is more demanding than least willow since it requires a base-rich soil to grow in. It is typically found at heights of between 600m (2000ft) and 1100m (3600ft) on the ledges of just such a base-rich rock

Not so small willows As well as these two tiny willows there are at least two others that, though not quite so small, are still a long way from most people's idea of a willow

Creeping willow is a small prostrate shrub found on dune slacks. It hardly ever grows taller than 10cm (4in) and its catkins appear before the leaves

Woolly willow is a giant compared with the species so far mentioned. It can reach a height

Above: The grey-green foliage of creeping willow (*Salix repens*), interspersed with strands of marsh horsetail (*Equisetum palustre*). Creeping willow is a typical plant of dune slacks (the wet areas behind sand dunes, such as the one in the picture).

Right: As with other willow species, the male and female catkins of creeping willow are borne on separate plants. The female catkins mature to form the fluffy white seed heads seen here

of 1m (3ft) and is a rare plant of damp, base-rich ledges on Scottish mountains. The leaves are twice as long as they are broad and at first they are covered with silky hairs on both surfaces. Later on the upper surface loses these hairs and becomes dark green, but the lower surface retains them. The catkins are golden yellow and oval if they are male or cylindrical if female

Dwarf juniper Juniper brings to mind a large bush, typically up to 3m (10ft) tall, but it is a very variable plant and specimens from one locality can look quite different from those growing somewhere else. There is, however, a mountain form which looks distinct enough to be called a subspecies; it is known as subspecies *nana*. Unlike ordinary juniper, the mountain form is hardly prickly to the touch, its leaves are not borne at such a wide angle to the stem, nor do they come to a point so suddenly.

Subspecies *nana* is found on mountains in north Wales, northern England, Scotland and Ireland. It has a trailing habit of growth (unlike the upright habit of ordinary juniper) and in extreme conditions it forms a hummock, usually up to 30cm (1ft) long and rising to no more than about 8cm (3in) high in the middle.

Dwarf birch Birches are familiar to everybody as large silver-barked trees. The silver birch normally grows to a height of about 25m (80ft) but, like the willows, it has a much

Above: The mountain form of juniper, known as *Juniperus communis* subspecies *nana* has a trailing habit of growth In extremely adverse conditions it forms a small hummock no more than 30cm (1ft) across and about 8cm (3in) high at the centre

Below: The tiniest of all our small willows is least willow (*Salix herbacea*) whose leaves are less than 2cm (¾in) long Shown here are the capsule-like fruits; the reddish tinges show that they are ripe

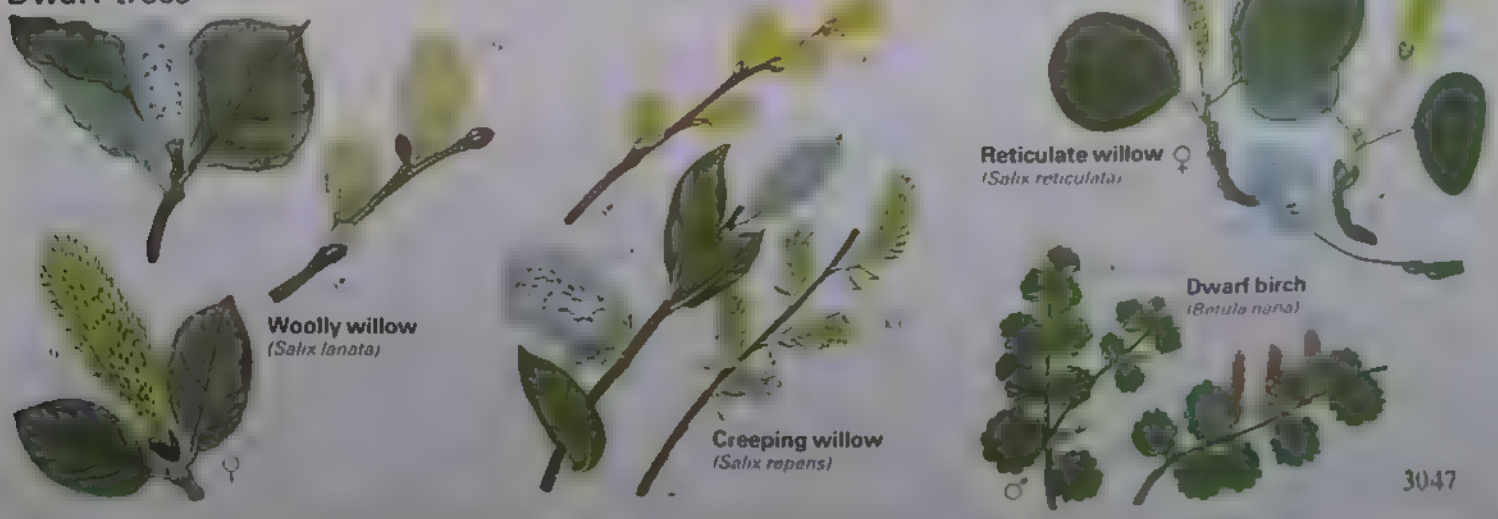
[illegible] rare plant and always an exciting find for the botanist working in the [illegible]

Dwarf birch [illegible] though it is much s[illegible] shrub about 90cm (3ft) tall [illegible] plant [illegible] bark [illegible] ately along the sho[illegible] ,in) long, more or l[illegible] deeply toothed [illegible] leaves are a bright glossy [illegible] been reported that they develop a golden tint before they fall in the autumn

Like willows, the flowers of dwarf birch are borne in catkins, which are either male or female, but, unlike willows, catkins of different sexes are found on the same plant. The catkins are oval and borne in the axils of the leaves the males are about 8mm long and the females 5-10mm

Dwarf birch has a very local distribution being found on moorland–especially boggy moorland at altitudes between 250m (800ft) and 900m (3000ft). In Britain it is found no further south than the Yorkshire Durham border and is most common in Scotland Elsewhere in the world it has an arctic distribution, occurring in northern Europe, Siberia, the Alaskan tundra and around the North Pole

Dwarf trees



NOCTURNAL LIFE IN THE SEA

Night diving is richly rewarding for the marine naturalist, for night is a time of great activity among the animals living in the sea.

The sea is a place of perpetual activity, and night is no exception. Filter feeding animals such as anemones, dead man's fingers, barnacles and tube worms are as active by night as they are by day. Their food is brought to them by water currents, and they have no need for stealth or concealment. Their times of activity and inactivity are not necessarily related to the cycle of day and night

However, there are many nocturnal sea creatures for which night offers better chances of finding food and evading predators, just as it does for nocturnal land animals such as owls and hedgehogs. Many, such as the brightly coloured squat lobster, *Galathea strigosa*, hide in crevices during the day where fishes and

Above: A squat lobster, *Galathea strigosa*, emerges from its daytime crevice to wander in the safety of darkness It feeds on algae and floating particles of detritus, as well as hunting small marine animals Squat lobsters sometimes take up a night-time position clinging upside down to an overhanging rock

Left A terebellid worm, a member of the large group known as the polychaetes. This animal hides under boulders and in crevices by day, emerging at night to crawl on the sea-bed. Why it emerges at all is something of a mystery: its long whitish feeding tentacles function just as effectively while it is still in its hiding place

[illegible] cannot reach them. Some animals [illegible] an eternal night because below a certain [illegible] there is no light [illegible] are specially adapted to a life of perpetual darkness.

Night fishes At night many fishes [illegible] for the diver [illegible] the best time [illegible] them. Dazzled by a torch [illegible] strangely shaped John dory [illegible] with its fins outstretched. Normally aggressive conger eels sometimes allow a diver to stroke them, and the timid leopard spotted goby (*Thorogobius ephippiatus*) emerges from its daytime crevice to feed on amphipods (small crustaceans) and worms. This beautiful, shy fish was once thought to be rare, but recently divers have found that it is widespread, living in steep, rocky areas of the sea-bed.

The venomous weever fish lies hidden in the sand for most of the day, and although it does feed during the day, it is more successful at night. It is also more active by day in areas where the water is dark and murky. This is also true of other animals, such as the long-clawed squat lobster (*Munida bamffica*), which normally hides under rocks in the day with just the claws showing. In deep, dark water they can be found in the open at all times.

In contrast to the night-active fishes, wrasse sleep soundly at night, wedged into crevices or deep among seaweeds. Often they can be picked up before they awake sufficiently to swim off. Shoals of pollack can be found resting quietly among kelp plants, their hunting over for a while. Some of these fishes, including wrasse, undergo subtle colour changes at night. Bars, stripes and spots appear and disappear, and many fishes become darker all over. (This can most easily be seen in an aquarium.)

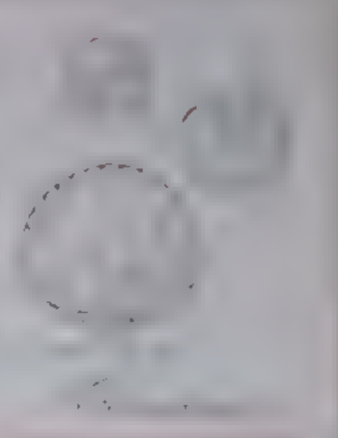
Night senses Many animals in the sea rely on their senses of smell and touch, and are not perturbed by their lack of vision at night. Fishes have a lateral line sensory system that detects low frequency vibrations caused by other fishes moving through the water or their own 'bow wave' hitting other objects. They are thus well able to swim freely around at night. Some deep sea fishes have especially well developed lateral lines. Other nocturnal and deep sea fishes have very large eyes which are sensitive to low light intensities.

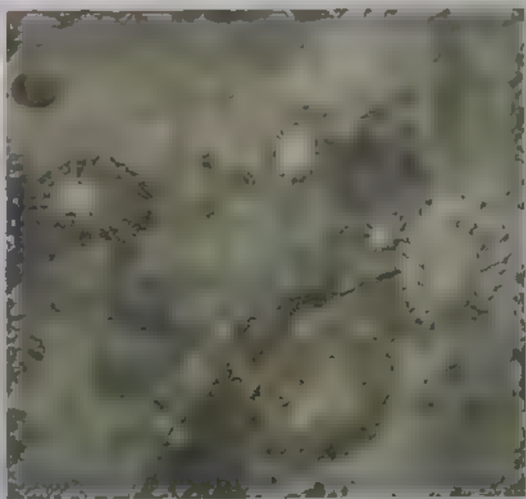
Skates possess another sense useful at night –electricity. Most can produce their own weak electrical fields that other skates can detect and recognise. In this way they can more easily locate others of their own species. If any object disturbs this electrical field, the fish can detect the change and thus 'see' in the dark. Dolphins and whales can hunt and move freely at night, using their sophisticated echo-location system much as bats do on land.

Bioluminescence This effect, also called phosphorescence, is one of the wonders of the sea at night. In calm summer weather, vast

How 'cold light' is made

[illegible] animals light is formed in an interesting chemical reaction [illegible] by an enzyme [illegible] product [illegible] oxidation [illegible] as light [illegible] light giving no heat the reaction is a more efficient way of making light. The small dinoflagellate *Noctiluca miliaris* [illegible] has exceptional luminescent powers for its size: its body contains thousands of light producing granules.





Above: The hermit crab's survival strategy is an alternative to nocturnality–with a shell to retreat into, it has adequate safety without the cover of night. It is therefore active by day and night

Right: Limpets remain motionless by day, but forage at night

Below: A leopard-spotted goby in night coloration white on the upper fins, and a darker body colour with a pinkish tinge

numbers of planktonic animals and plants accumulate at the sea surface and some of these, particularly dinoflagellates such as *Noctiluca miliaris*, produce light. When waves break, or a boat or a swimmer passes, the movement of the water disturbs the plankton and causes it to emit light. For the diver, it is like swimming through star dust as his fins and bubbles disturb the water. The cold light of phosphorescence is a product of the oxidation of a substance called luciferin

Above: A velvet swimming crab, *Liocarcinus puber*, photographed in Lough Hyne in south west Ireland The mouthparts, eyes and claws are particularly clearly shown. Though small numbers of this species are seen in daytime, many more emerge at night to prowl on the sea-bed

Many other animals have the power of bioluminescence, especially fishes of the open ocean and deep sea. The little lantern fishes (myctophids) have special organs called photophores that emit light. The photophores contain gland cells which secrete a chemical that produces the light. In some species, the photophores contain luminous bacteria

At night, lantern fishes rise towards the surface of the sea, where they can sometimes be seen from ships. The functions of the luminous organs are not well understood. In the eternal night of the deep sea they may serve the same function as the markings of shore fishes–allowing the fishes to recognise their own species. In the lantern fish, the number and pattern of the photophores provide the means for distinguishing the different species. The luminous organs may also light up the water in front of and beneath the fish, helping it to find prey, and they may also confuse predators.

Some deep sea shrimps and squids produce clouds of a luminous substance when attacked -rather like the ink clouds of shallow water squids

Night migrations An amazing mass migration occurs every night in the sea. When darkness falls, the tiny planktonic animals migrate upwards, often for many hundreds of metres, to feed on the plant plankton in the upper levels. Considering their size, this is no

The sea at night

1 Anemones: active day and night.
2 Barnacles: active day and night
3 *Noctiluca*: bioluminescent plant plankton, activated by water movement
4 Leopard-spotted gobies: emerge at night to sit on rocky ledges outside their crevice homes, waiting to pounce on small animals passing by.
5 Ballan wrasse: sleep at night, wedged into crevices or in other resting places
6 Squat lobster: active at night, either eating detritus or catching live prey.
7 Long-clawed squat lobster: active at night; this is a deep-water species, occurring less frequently on the shore
8 Shoal of pollack: resting in a kelp bed
9 Conger eel: emerges from its lair–either a gully or a hole in the rocks–to hunt stealthily by night. Sometimes congers go on extended night forays, far out to sea.
10 Greater weever fish: active at night in deep water.
11 John dory: an easy fish to study at night, for it becomes less timid
12 Shoal of mackerel: feeding on plankton at night
13 Lantern fishes: bioluminescent, rising towards the sea surface at night
14 Skate: produces an electric field which it uses as a night sense.
Note: this illustration is a 'composite'–no diver would ever be so lucky as to see all these species in the same place at one time

mean feat equivalent perhaps to running a marathon before breakfast every morning. In the Atlantic, for every square metre of sea surface about six tonnes of plankton migrate up into the top 200 metres (100 fathoms). In turn, about four tonnes of shrimps and other small animals follow them up to prey on them, and some deep sea fishes follow the shrimps from as deep as 1500 metres (800 fathoms). This is often known as the ladder of migrations: each animal moves up by a certain number of rungs.

Seashore at night Activity on the seashore is controlled mostly by the tidal cycle. However, many more animals move about during a low tide at night than during one in the day. At night it is cool and damp, and there is much less danger of desiccation. Limpets normally cling tightly to the rock surface when the tide is out, and keep water beneath their shells. At night, they can move freely over the rocks feeding: they graze small algae from the surface of the rock. Logically enough, each limpet returns to its own exact place on the rock, for that is where it fits perfectly.

Darkness also provides protection from predatory seabirds. On sandy beaches in spring, the masked crab (*Corystes cassivelaunus*) gathers in mating groups during low tides at night. The large and beautiful worm *Phyllodoce paretti* hides in crevices in the day, but large numbers crawl over the shore at night.

Above: A corkwing wrasse. It was only by observing wrasses in an aquarium that scientists learnt that these fishes sleep at night, finding a suitable ledge or crevice in which to rest.

Right: The butterfish lurks in crevices during the day; here it is seen emerging at night to catch small animals such as shrimps and worms. Unlike the wrasse, most fishes sleep in short naps, which they take from time to time either by day or by night.

MIMOSA AND OTHER ACACIAS

Of the 700 species of *Acacia* in the world, only about 20 can survive in the milder areas of the British Isles, although they are susceptible to frosts. Their sweet-smelling fluffy yellow blooms make them popular in florists' shops.

The florist's mimosa (*Acacia dealbata*) with its attractive silvery, fern-like foliage and fragrant, clear yellow flowers, is a member of the pea family. However, mimosas have different flowers from the normal 'pea' flower with its large, unequal, over-lapping petals and joined stamens. Mimosas and other *Acacia* species have small, equal petals that do not overlap and numerous long, separate stamens. These stamens are the most noticeable feature of the flowers, which are tightly clustered together in globular or elongated heads. Because of this different flower structure, mimosas are usually placed in a separate subfamily, or even a distinct family, from the peas and clovers.

World-wide distribution There are over 700 species of *Acacia*, most of them drought-resistant trees or shrubs from tropical or temperate parts of the world. About half the *Acacia* species are native to Australia and Tasmania, where they are called 'wattle': this name derives from the use of *Acacia* stems by the earliest settlers in the construction of mud and wattle huts. In Africa *Acacia* is again important as the various [illegible]rn trees that dot the savannah. Species also occur in India, South America and Central America.

Acacia species are planted in many warm temperate areas, especially the Mediterranean region where they are extensively naturalised. The plants are used for ornament, soil or sand stabilisation, timber and even perfumery. In some places they are so abundant that they give the impression of being native vegetation.

In the milder parts of the British Isles around 20 species are grown in the open, most of them Australian or Tasmanian. Unfortunately, only a handful are moderately hardy. The majority of plants in parks and larger gardens are still only young but growth is rapid and the plants soon reach flowering size. Various species are reported as naturalised from time to time, mainly in the West Country, the Channel Islands and south-western Ireland. While plants can survive the occasional frost, it is unlikely that any population is able to survive a really hard winter.

Mimosa or silver wattle The florist's mimosa is probably the best-known species in the British Isles: it is called the silver wattle in Australia where it forms a tree up to 30m (100ft) tall. In this country it is usually a shrub of about 6m (20ft) and only rarely exceeds 20m (65ft). Leaves of the silver wattle are

Above: The florist's mimosa is probably the best known *Acacia* species in the British Isles. Most of the cut flowers come from the south of France where the trees grow in such profusion that whole hillsides are turned a delicate shade of yellow in winter and early spring. In this country it is usually a shrub about 6m (20ft) high.

Right: Wirrilda is one of the hardiest *Acacia* species. It is cultivated here

doubly pinnate, giving the foliage a delicate feathery appearance. Each leaf has 8-20 main divisions (pinnae) and 30-50 final divisions (pinnules), so that there is little else either native or naturalised in the British Isles with which this species might be confused.

Young plants have bluish-green stems which develop into smooth or slightly fissured grey-brown bark. The globular heads of flowers have the typical long protruding stamens of the genus, forming the main part of the display. Ten to thirty globular heads are carried in branched clusters; the seed pods are bluish-white and flat.

Blackwood The juvenile foliage of the blackwood resembles that of the silver wattle but the adult foliage is quite different and looks superficially similar to that of a eucalypt. Blackwood is native to Australia, where it is an important timber tree up to 40m (130ft) tall. It is cultivated and naturalised in Europe and, as it is rather hardier than the silver wattle, it reaches substantial proportions in Britain and Ireland. Blackwood has been recorded as naturalised on sea-cliffs in Devon, and it regenerates from seed in many areas. Inside the pod each seed is borne on an unusually long and fleshy scarlet or orange-pink stalk (the funicle) which is bent back on itself in a double fold. The purpose of this stalk is to make the glossy black seeds appear attractive to birds when the pods split open.

Wirrilda A smaller tree than the blackwood, often described as a shrub, the wirrilda or swamp wattle is native to Tasmania and Australia where it grows up to 10m (33ft). Its leaves (known technically as phyllodes) are similar to those of the blackwood but they tend to be narrow and so look a bit like a willow when it is not in flower. Given mild weather, the pale flowers may appear in any month of the year; in Australia the plant is sometimes known as the 'four seasons wattle' for this reason.

The wirrilda is widely planted around the Mediterranean, and is naturalised in many areas as far north as western France or occasionally south-western Britain and Ireland. Although not the most attractive of the wattles, the wirrilda is one of the hardiest and is usually lime-tolerant.

Sydney golden wattle Of the other *Acacia* species cultivated in the British Isles, one of the most distinctive is the Sydney golden wattle. It is similar in overall appearance and hardiness to the wirrilda but has rather broader, blunt foliage. It is easily distinguished by its strongly scented slender spikes of flowers. In fruit, the stalk of the seed is much shorter than that of the two preceding species and is white.

False acacia Sometimes called the false acacia, the locust tree (*Robinia pseudoacacia*) is a much commoner tree in Britain than any of the wattles and should not be confused with the true *Acacia* species. False acacias are much more typical members of the pea family: the leaves are compound with leaflets arranged along each side of a stalk and the flowers are relatively large compared with those of *Acacia*, have unequal petals and are borne in long hanging racemes.

Left: The grey, fissured bark of the blackwood, one of the hardiest of the *Acacia* species and one that can survive in the British Isles. The tree may grow to a substantial size in mild, warm areas, particularly the sea-cliffs of Devon where it is naturalised in a few places.

Above: Four of the most common species of *Acacia* found in the British Isles. The florist's mimosa (*Acacia dealbata*), sometimes also called the silver wattle, usually grows to a height of 6m (20ft) in this country and only rarely reaches as tall as 20m (65ft). The blackwood (*Acacia melanoxylon*) grows to 15m (50ft), though it is also usually much shorter than this, while wirrilda (*Acacia retinodes*) is scarcely a tree and is probably better described as a shrub. The Sydney golden wattle (*Acacia longifolia*) is similar to the wirrilda in overall appearance

THE COTSWOLD WATER PARK

"The new Broads" is how one observer described the Cotswold Water Park, and looking across the dozens of flooded gravel pits it is easy to see why. Like the Broads, the Water Park holds both opportunities and problems for our wild plants and animals.

Below: Beds of reedmace by one of the lakes. Most of the lakes are privately owned, and many are dangerous for the unwary visitor, though one lake in the Ashton Keynes section is a nature [illegible]

The Cotswold Water Park straddles the Wiltshire-Gloucestershire county boundary and is divided into two sections, one to the west centred on Ashton Keynes and South Cerney, and one to the east between Lechlade and Fairford. Together they comprise an area of about 5700ha (14,000 acres) of gravel-bearing [illegible] been formed around a series of flooded gravel pits.

Before gravel digging began the area was [illegible] cattered [illegible]. Doubtless many of the fields would have been rich in the old [illegible] permanent pastures. Some such areas still [illegible] near the Water Park and such plants as green-winged orchid [illegible] adder's tongue and the local specialty snake's-head fritillary, grow there. However, as elsewhere, modern agriculture has produced larger fields more [illegible] for dairying and cereals and these, not [illegible] pastures, now frame the gravel pits.

Gravel lakes The Cotswold Water Park is fundamentally an area of sand and gravel deposits. These deposits are 4-6m (15-20ft) thick under a shallow topsoil and subsoil, and are of great economic importance. The site has been worked since the early 1920s and the mineral industry is well established locally both for the extraction and the subsequent

manufacture of concrete and concrete products. Output has increased several times over since the 1940s, reaching a peak in the mid 1970s (helped by the construction of the nearby M4 and M5 motorways).

Because of the high water table, which is usually 1m (3ft) or less below ground level, excavated pits readily fill with water and form lakes, the water coming from rainfall and from inflowing springs rising in the calcium rich limestone rocks of the Cotswolds to the north. The gravels themselves are also largely derived from limestone–consequently the water of the lakes is rich in calcium and very alkaline. Indeed, under certain conditions solid calcium carbonate may be precipitated out of the water forming a deposit called 'marl'. The lakes of the Cotswold Water Park are considered to form the largest area of marl lakes in Britain.

Lake invaders Plant colonization of both the open water and the lake margins can be a slow process, the reason being that modern gravel working methods often produce deep water right up to the bank. Under such conditions no marginal vegetation can develop and instead the bank may become overhung by brambles and dog roses or by branches of hawthorn, willow and alder trees. However, in time the water cuts into these banks and produces shallow gravelly ledges which can then be colonized by plants. Reedmace is one of the first plants to establish in such shallow margins in the Water Park and most of the lakes have some small narrow reedmace beds, while a good number have much larger beds.

The common reed, which is usually a familiar plant on the edges of rivers and lakes, is not as common as might be imagined. Possibly the largest stand of it is associated with the outflow of silt from a gravel-washing plant, showing it requires rather particular conditions to grow well. Large tufts of rushes, notably hard rush, dominate the shore line in some other places while more occasional stands of club rush are found scattered among the reedmace.

Lake aquatics The establishment of truly aquatic plants in the Water Park appears to be related to the chance introduction of seeds or pieces of stem, and also to the depth of water in the lake. Aside from a few microscopic algae, like *Spirogyra* and *Oscillatoria*, the first colonizer is often a species of stonewort. These are primitive flowerless plants lacking roots and with the plant surface made stiff by an encrusting of lime. Several different species have been recorded and the common stonewort is present in many water bodies.

Six different species of pondweed have also been recorded from the Cotswold Water Park. These include species with broad leaves, such as the shining pondweed (another plant that is often covered with lime), and species with narrow grass-like leaves, such as hair-like and fennel pondweeds. Other aquatic plants noted

Above: An alder tree with its fruits, known as 'cones'. Among the trees found in the Cotswold Water Park, some are naturally established–for example, oak, field maple and common buckthorn, which date from the presence of old hedgerows on the site. Other trees, however, have been planted by man. It is hard to tell whether the alders that occur around the pits fall into the first category or the second.

Right: Hemp agrimony is found in damper ground in the Water Park.

Below: A family of young sand martins. These birds often breed in sandy cliffs, and even the more gravelly ones, in the Park. In one year alone, more than 800 nest holes were counted.

from the area are spiked water-milfoil, rigid hornwort and fan-leaved water-crowfoot

Behind the shoreline The vegetation of the banks behind the shoreline is quite variable Initially the bare soil surface is colonized by species typical of waste ground–docks, thistles and goosefoot, together with groundsel, colt's-foot and stinging nettle, are common components. After a while the vegetation becomes thicker, and taller grasses such as oat-grass and cock's-foot become abundant. With them, however, grow a variety of taller flowers such as knapweed, hogweed and ragwort on the drier areas and meadowsweet, hemp agrimony and fleabane on the damper ground.

In some places, probably over long-forgotten gravel heaps, a short calcareous turf develops. Growing here are bee orchid, felwort and devil's-bit scabious, all of which also grow on the old limestone pastures to the north and west

Birdlife Despite the variety of plants in and around the lakes, most naturalists are attracted to the Park by the birds. The variety of habitats created during gravel extraction provide conditions that attract a wide range of birds throughout the year

During the winter months the lakes hold large numbers of ducks, especially diving ducks. The wintering populations of pochard and tufted duck are regarded as nationally significant. In most winters there are at least 1500 of the former and 700 of the latter In exceptional circumstances, mainly related to particular weather conditions, the numbers of these and other wintering species may be much higher. The most numerous water bird at this time of year is the coot, whose numbers can top 4000 in some winters. Coot, pochard and tufted duck all feed in open water around

Above: So far, 17 species of dragonfly and damselfly have been reported from the area this is about 40% of all the species recorded in Britain One of the dragonflies you are most likely to see is the common sympetrum

Right Many thousands of black-headed gulls pass the winter at the Park particularly at one of the lakes in the western part near South Cerney. Here you can sometimes obtain good views of the gulls flighting in to roost from the disused railway bridge near the main road through the Park

Below. Great willow-herb, a common species around the margins of the lakes

1-3m (3-10ft) deep

Other water birds frequently seen in winter include mallard, wigeon and teal, mute swan and great crested grebe. There is also a large winter roost of gulls on one of the biggest lakes near South Cerney.

Some of these wintering birds remain in spring to breed on the lakes. Mallards are certainly quick to use suitable localities and both tufted ducks and great crested grebes have nested in increasing numbers over the last ten years. The breeding requirements are rather different to those needed for over-wintering. The presence of sheltered shallows and bays, islands and marginal vegetation is all of considerable importance for successful breeding. Tufted ducks prefer the islands for nesting and they and the mallard need sheltered water for raising their young. The emergent vegetation, such as the reedmace beds, are essential for great crested grebes and coots to nest, while other water birds like moorhens also make use of these plants but may in addition nest in the low branches of trees.

Land birds The thickets of reedmace willows and other plants also provide nesting sites for sedge and reed warblers and for reed buntings. Some scrub areas attract breeding passerine species, among which the nightingale and lesser whitethroat are the most noteworthy. Sandy cliffs, and even rather gravelly cliffs, often attract breeding sand martins, but such cliff faces are often transitory affairs, being associated with a certain phase in the sequence of operations in gravel working: they may soon be dug away again or, if not, become colonized by vegetation making them unsuitable for the birds

Another species that breeds on temporary features is the little ringed plover. A few pairs nest in most years on bare gravel areas but such features are quickly lost under vegetation unless positive steps are taken to keep them open.

Also of interest to the birdwatcher are the small pools and wet patches in the muddy bottoms of actively dug pits. In such pits there is a constant flow of water coming in, which the pit operators have to remove by pumping In practice, however, it is impossible and unnecessary to remove all the water, hence the wet pit-floor, which is a great attraction for waders during the migration seasons of spring and autumn. Seen almost every spring are black-tailed godwit and sanderling, while late summer and autumn may well produce little stint and wood sandpiper. Other scarce birds which have been recorded in the Water Park in the last decade include gannet, scaup, osprey, black tern and water rail. However the chances of seeing these depend on regular visits to likely areas and good luck!

Other animal life The Cotswold Water Park has, of course, its share of more sedentary creatures. Various species of fishes are taken by anglers, roach, perch and pike probably being the most widely occurring, though there is much variation between the lakes

Those who sit on the banks in the summer cannot fail to notice the numbers and variety of damselflies and dragonflies that fly around the pits. The common blue damselfly lives up to its name and is very abundant in places while two of the commoner dragonflies are the brown aeshna and the common sympetrum Most of the other groups of insects have been little studied but some of the more familiar butterflies and grasshoppers may often be seen in the longer grass around the pits.

The future The Cotswold Water Park was created by man, yet its habitats have a future as uncertain as many of our more natural areas. Many of the features of particular interest are transitory, such as the muddy pit-floor, open gravel area and sandy cliff, and depend on continued gravel working. Ultimately, perhaps a nature conservation body may have to simulate those conditions if the wildlife is to be maintained. Likewise many species of plant, bird and insect only establish themselves dependably if large enough areas of, for example, reed bed or willow thicket can be created Conservation is badly needed here

Of course, a wide variety of flora and fauna manages to flourish alongside many of the current uses of the lakes–sailing, windsurfing angling and so on. But the full potential of the area will not be realised, nor the present value maintained, without active provision of the necessary conditions

Above: The Cotswold Water Park is divided into two parts, the Ashton Keynes section to the west and the Fairford/Lechlade section to the east

Below: The fruiting head of reedmace in the middle here shows why this plant is sometimes called bulrush

WHICH INSECTS BITE US AND WHY?

Out of the 20,000 or so insect species in Britain, only a very small proportion–about 50–go out of their way to attack man; these are the extremely persistent blood-suckers. Other insects that bite, stab, or sting us are merely defending themselves.

Most persistent and purposeful of the insects which attack man are the blood-suckers. They belong to four main orders: the true flies (Diptera) which include mosquitoes, biting midges, black-flies and horseflies; the fleas (Siphonaptera); certain bugs (Heteroptera), of which the bed bug is by far the most important species; and the sucking lice (Siphunculata). All require the blood of mammals, birds and occasionally other vertebrates, for both food and the proper maturation of their eggs. In most blood-sucking flies (Diptera) it is only the females which are capable of feeding in this way–the males are innocuous and must content themselves with nectar, since their mouth-parts are not adapted for piercing skin

Blood-sucking Diptera Mosquitoes typify the outdoor blood-feeders and, like many other groups, can be extremely persistent in returning again and again to their unwilling host, often in considerable numbers. Especially active in marshy areas, as well as by ponds, lakes and water-filled ditches (in which the aquatic larvae develop), some 30 species of Culicidae occur in Britain, although by no means all of them attack man

Most mosquitoes provide some warning of imminent attack with a high pitched whine produced by their wing beats, but other dipterous blood-suckers are far more insidious in their approach. Some horseflies fly

Above: Anyone with the misfortune to come into close contact with a wood ant nest knows that these small social insects defend themselves by spraying intruders with formic acid This produces a mild prickling effect.

Right: Horseflies are particularly unpleasant biters as some approach and then alight on their victim in absolute silence, only betraying their presence when they have pricked the skin.

Stingers and sprayers

Honey bee
(Apis mellifera)

Wood ant
(Formica rufa)

Above: Some caterpillars–such as those of the commonly seen vapourer moth–cause varying degrees of irritation on young and sensitive skins by shedding their bristly hairs. Even by handling the pupae and eggs you are running the risk of a subsequently itchy skin: the caterpillars mix their hairs into the cocoon in which they pupate, and the adult females decorate their egg batches with bristles from the tips of their bodies. In some moth species irritation is caused by toxins in the caterpillars' hairs, but with others the reaction to their hairs is purely physical Vapourer moth caterpillars feed in May and June on a number of plants, but particularly oak, lime and hawthorn trees

up and alight on the skin in absolute silence until a sharp prick betrays their presence. The small, mottled, greyish cleg is one of the commonest and most persistent attackers, especially in thundery conditions near lush vegetation. Another troublesome species is the thunder fly, conspicuous for the large black markings on its wings.

Smaller culprits Many blood-sucking Diptera are extremely small, although their attentions can be no less irritating. The black-flies, characterised by their large thorax, often attack in clouds near running water. The tiny biting midges of the family Ceratopogonidae, similar to small mosquitoes but with much shorter legs, are a nuisance in damp places in summer. By contrast, winter gnats, the males of which are commonly seen conducting communal courtship dances on sunny winter days, do not suck blood.

Fleas: incessant biters Fleas are close relatives of the Diptera which have abandoned flight in favour of a totally parasitic existence. They afflict a wide variety of nest-building mammals and birds and exhibit varying degrees of host specificity. The human flea, for example, may share its attentions equally between man, pigs and badgers, but hedgehog fleas only rarely abandon their prickly hosts

Unlike adult fleas, larval fleas are not blood-suckers. Instead they feed on skin fragments and the adult's blood-rich excreta which falls to the floor of the host's lair.

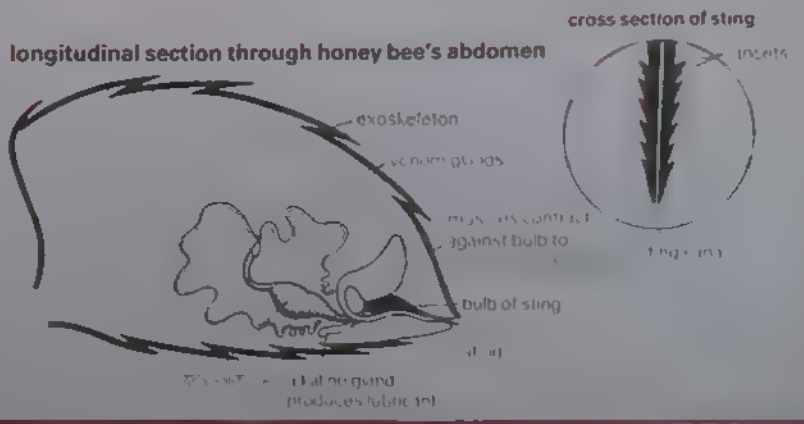
Domestic pests Bed bugs and lice present a further variation on the blood-sucking theme in that both the adults (male and female) and the young nymphs feed on blood. Pale brownish in colour, the bed bug is easily recognised by its very flat, almost circular abdomen, which becomes darkish red or purplish in colour and greatly distended after a blood meal Bed bugs do not spend all their time on the host's body, but feed mainly at night, seeking cracks in the floor boards or walls at other times.

Lice are more numerous in species, the best known being the human louse which produces nits–tubular eggs cemented to the roots of the hair. The species occurs in two distinct races, *Pediculus humanus capitis* infesting the head and hair, and *P. humanus corporis* which is found on the trunk.

Extracting the blood The natural reaction of

Death: the price of a bee sting

The ovipositor of a honey bee worker has lost its egg-laying function in the course of evolution and become modified as a weapon for defence: the sting. If a bee lands on a human and senses danger its nervous system responds by causing certain muscles to contract and push out the sting–an organ consisting of two sharp lancets (with barbs) and a protective sheath, all surrounding a central sting canal The two lancets are lubricated by the alkaline gland and slide over one another until they have sufficiently penetrated the flesh. A portion of venom is then pumped from the venom sac, down the sting canal and into the victim's tissues Usually the bee is unable to withdraw its sting and must leave it in the flesh; in such instances it soon dies.



Above. Contrary to popular belief, wasps do not often use their stings against man unless they are handled, trapped in clothing or disturbed from their nests

Left: *Culiseta annulata* is Britain's largest mosquito, and commonly hibernates in houses, often waking up to feast from sleepers.

Below: *Mutilla europaea* is one of two velvet ant species in Britain, and it has a very painful sting

blood to any skin perforation is to form a clot, thus sealing off the wound and preventing infection. Blood-sucking insects counter this problem by injecting an anti-coagulant in their digestive saliva which prevents clotting and allows the sucker to take an uninterrupted meal

All blood-sucking insects have mouthparts which are adapted on broadly similar lines, although differing in detail. In bed bugs, for example, only the modified mandibles (main jaws) and maxillae (accessory jaws) are used for blood-sucking, whereas in the flies the entire mouthparts may be utilised.

Transmitting disease Insects such as mosquitoes, fleas and lice can act as carriers of disease by transporting the viruses, bacteria and protozoa which cause yellow fever, typhus, plague and malaria from host to host. There is very little chance of this happening in Britain, however, since the insects' disease-conveying potential depends on their extracting blood from an already infected human.

Nevertheless, the effects of simple blood extraction can sometimes be quite severe, depending on the individual host. Those with mild allergies or blood disorders, such as anaemia, are likely to experience particular irritation from the extractor's saliva and anti-coagulant. Moreover, some people are more prone to initial attack, perhaps because they overheat and perspire more readily and thus send out signals to blood-suckers.

Defensive stingers The possession of a sting for defensive purposes is almost solely confined to the Hymenoptera–bees, wasps and ants. Such an armament is found only in the queens and workers since the sting is really a modified ovipositor. The queen or worker may still lay eggs from the base of its ovipositor, but the remainder of this organ is given over to injecting venom.

In most cases the sting is used solely against attackers of the community or to subdue prey –it is not often used against man unless the insect is disturbed. Even the large and much-feared hornet is of a mild disposition as far as man is concerned.

Defensive sprayers The poisons injected by stinging insects consist of various proteins, amino acids and enzymes, and in some ants, formic acid. Wood ants are among several species which are unable to inject formic acid by means of a sting. Instead they spray it at intruders, producing a mild prickling sensation.

Some caterpillars, such as the puss moth and the lobster moth, are also capable of discharging formic acid from a special gland in the thorax, but they rarely use this as defence against human handlers. Many beetles can exude irritant substances when handled, though, but most of these only have a mild effect. One exception, however, is the rare blister beetle which contains a substance, called cantharadin, in its blood that can raise blisters on the skin.

SHEEP FARMING IN THE BRITISH ISLES

Despite subsidies which favour the large-scale mechanised farmer, and the adoption of a complex, multi-layered breeding strategy, sheep farming in the British Isles remains the most traditional branch of our agriculture. Throughout the seasons the flocks must be carefully tended by the farmer.

Above: A traditional sight as the farmer and his shepherd move their sheep to new ground during the middle of winter. As lambing time draws near, sheep in more exposed areas are brought down to fields nearer the farm.

Below: Suffolk sheep, an old breed are now used extensively in the British sheep industry. The tenderest meat comes from the male lambs.

Towards the end of the summer the shepherd makes a careful check on his flock. It is an occasion for sound judgement based on accurate records and years of experience, for sheep are difficult animals to assess. A dense coat of wool disguises their true condition, and the shepherd must learn to handle his stock and feel for any problems through the fleece. He must learn to interpret odd behaviour, and remain alert to the slightest symptom which could betray ill-health. With winter imminent, and the new breeding season about to begin, the flock must be relieved of any old, weak or unpromising animals if it is to remain productive.

Wool and lamb Productivity, for the average sheep farmer, is measured by lamb output. The wool clip, while a useful bonus, accounts for only 8% of the income from sheep in the British Isles; most of the rest is derived, directly or indirectly, from the 'lamb

crop'. The term is appropriate, for on many farms the lambs are regarded as an annual harvest to be sold as soon as possible, whereas the breeding flock represents the working capital of the enterprise, fed and maintained for production, and replaced when it wears out.

In mountain and moorland areas the retirement age for a ewe (breeding female) is relatively low. Only the fittest animals can cope with the combination of harsh climate and poor grazing, and even their productivity is unsatisfactory by lowland standards. The sheep are bred for hardiness and self-reliance; the ability to survive a blizzard on the mountain, and raise a lamb under such conditions, is more important than the rate of reproduction. Mountain ewes are noted for their maternal qualities, but not for their lamb output, and while the lowland sheep farmer aims for a 200% lambing average (two lambs raised per ewe), the upland farmer is lucky if he achieves half that from a flock run on the hills.

Lowland rearing If the same sheep are brought down into the valleys their performance improves in response to the milder climate and better pasture. The improvement does not justify giving up the cheap grazing of the high tops, but it is sufficient to give a new lease of life to ewes which have been retired from the main flock. As the shepherd checks over his stock, therefore, he gathers together all the ewes which have seen three years on the mountain and packs them off for the good life in the valley, along with the lambs born earlier in the season

The ewe lambs destined for the main flock are also sent down to better conditions to ensure they develop unchecked by the rigours of a winter in the hills. They are kept on the parent farm, or if necessary on rented pasture Most of the male lambs are fattened up over the winter for market, but the best of them are reared as rams for eventual sale or use in the main flock (taking care to avoid uncontrolled inbreeding).

The mature ewes drafted from the highlands are normally auctioned at the draft ewe

Above: Market day at Louth in Lincolnshire. Lowland farmers try to take their lambs to market at about four months old if they are to be sold for their meat Mature ewes and rams are also offered for sale–a well-bred ram can fetch thousands of pounds

Below: Hybrid ewes (Mules) which have been covered by the Suffolk ram are marked by a red crayon that is harnessed to his chest. The others await their turn

sales in the autumn. They fetch a good price, for they have at least two seasons' lambing ahead of them, and the qualities which sustained them on the hills make them valuable to buyers.

Upgrading the flock With the proceeds from his draft ewes in his pocket, the hill farmer moves on to the breed association ram sale The animals for auction here are of the highest quality, carefully selected to perpetuate the best characteristics of the breed. The farmer will have rams of his own in the ring, in the hope of covering the expense of purchasing new blood for the flock. An ambitious farmer will always want to buy better than he sells, however, and the cost of a well-bred ram is justified in the long term by the quality and consequent value of his offspring

Having bought his rams, the farmer is well-equipped for the mating season, otherwise known as tupping. (Shepherding has its own obscure but ancient language, baffling in its local diversity.) In the hills tupping starts just before Christmas, later than down in the mild lowlands. This is to delay lambing until the worst of the winter is past. The ewes are put on to a better diet to get them into good condition ('flushing'), separated into groups according to the breeding strategy and moved into enclosed fields under the eye of the shepherd.

Enter the rams, one to every 40 or so ewes, each equipped with a marking crayon strapped to his chest. By this means the shepherd can tell which ewes have been covered and by which ram. The information is duly noted down in the record book. When every ewe sports a bright patch of colour on her rump the rams are called off, and the shepherd can settle back to await developments.

The hill farmer wishes to improve the quality of his purebred flock by a careful mating policy, but the lowland buyer of his

Above: Outwintered sheep on the Berkshire Downs rely on regular supplies of hay for their winter food

Right. Lambing time, and a ewe licks her newly born lamb. Nowadays, a bereaved ewe is fooled into adopting another's lamb by masking its alien scent with an aerosol spray

Below: Scottish Blackface lambs, one of the hardiest of the sheep breeds, are tolerant of poor conditions

draft ewes has different aims. The typical mountain ewe, although strong on hardiness, thriftiness and maternal instinct, has a poor lambing performance and an inadequate meat conformation (an expression of quantity rather than quality–the highly-regarded Welsh lamb is of mountain origin)

By contrast, there are certain breeds of sheep, derived from the big lowland long wools which dominated sheep farming before 1800, in which the qualities are reversed: they are well-built, prolific (having a high lambing average) but intolerant of bad climate or poor-quality feed. By a happy accident of genetics the progeny of such a ram mated with a mountain ewe combines the best qualities of both breeds, laced with something of the hybrid vigour which distinguishes all first-crosses. The ewe lambs of this union are in great demand as the ideal breeding stock for the lowland farmer, being self-reliant, strong, economical and prolific.

Come tupping time, therefore, the draft ewes are put, not to a ram of the same breed, but to one of these 'crossing' breeds: a Border

Leicester, its more refined cousin the Blue-faced Leicester, or a Teeswater. The ewe lambs are sold as Halfbreds. Mules and Mashams respectively, and these are the sheep most likely to be encountered outside the highland regions. They in turn are mated to a big meaty ram, usually one of the 'down' breeds developed in the 19th century–a Hampshire Down or a Suffolk–or perhaps a Texel from Holland, to produce the lamb crop. This system, known as stratification, is the basis of the British sheep industry.

Lambing A ewe is in lamb for 21 weeks, throughout the worst of the winter. Up in the hills, the shepherd must be alert to changes in the weather, and be ready to distribute extra hay or, if necessary, bring the flock down to the safety of the farmstead. All too often the weather closes in without warning, and the news is full of sheep being fed by helicopter or dug out of snowdrifts

Some of the bigger farms, encouraged by the high prices offered for lamb under the EEC sheepmeat policy, have taken to providing winter accommodation for the less hardy flocks; in general, however, sheep are expected to winter out. In the uplands, ranging over a wide area, they may find much of their own food. On more intensively farmed land they are fed on hay and silage, and specially grown forage crops such as turnips and kale. As they eat their way across the field they improve its

Above and opposite left Sheep shearing on a farm in Romney Marsh, Kent In flocks kept particularly for their wool, this is naturally a big occasion and a large shearing gang is hired for the job. World records are attempted: using electric clippers an expert can remove an unbroken fleece in 60 seconds On most British farms, shearing is a much more casual affair and the opportunity is taken to examine each animal carefully for injury or disease, and to dose against parasites

Left. A shepherd in the Hebrides marks his sheep after shearing

Right: A pen of Hampshire Downs–meaty, stocky sheep which are crossed with hybrid ewes to produce excellent lamb

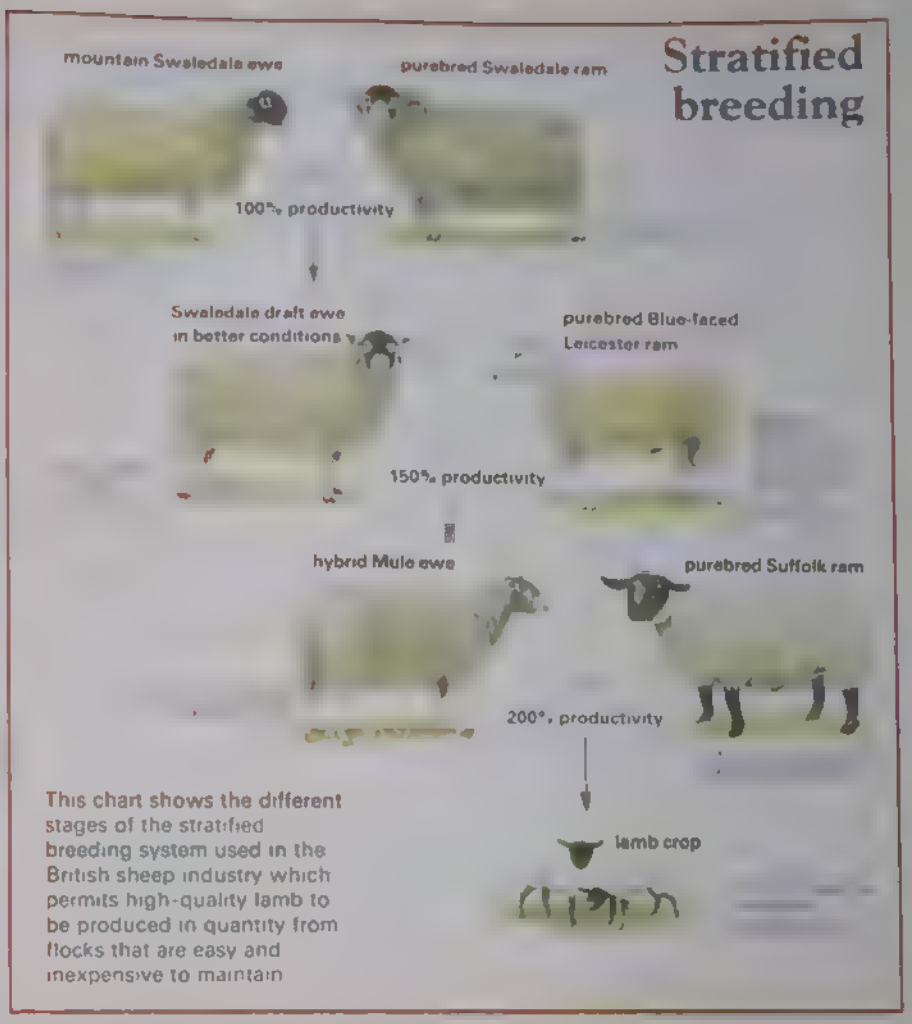
fertility by trampling in a combination of manure and crop remains, leaving the land in good heart for spring-sown cereal crops

As lambing time approaches the food ration is increased, and the ewes are transferred to a sheltered field or building. Temporary lambing pens built of hay bales are erected, and the shepherd starts his vigil. Most ewes have no difficulty, but he must be on hand to help if required, and he gets little sleep. Twins are common, and triplets not infrequent particularly among the lowland flocks. There are also losses, and a good deal of fostering is practised

A lamb relies on its mother's milk for two or three weeks, and hybrid ewes are bred to produce plenty of milk off the spring grass After ten days the lambs begin to nibble at the grass themselves, and lowland farmers may employ a system of 'creep grazing'. The lambs are allowed on to clean, new grass through small holes or 'creeps' in the fence; in due course the ewes are let in to finish up the grass, and the lambs are given access through creeps to the next ungrazed field. The technique ensures that the lambs get the pick of the spring grass without being separated from their milk supply, which is essential in their early life.

Summer months As the weather warms up, the mature sheep are gathered for shearing, and at the age of three to four months the lambs sired by the Down rams in the lowlands are normally sufficiently well-grown to send to market as 'fat lamb'. This is a misleading term, for despite their size they are very lean, and the source of most of the prime lamb in the shops. Any lambs not sold are weaned at four months, and the ewes are put on to poorer grass to cut off their milk supply. The lowland farmer will try to get his lambs away as soon as possible, but if the market is favourable he may decide to fatten them up over the winter on grass and forage crops, and sell them in February under the name of heavyweight lamb.

In late August or early September the flock is dipped as a precaution against sheep scab, a notifiable skin disease caused by mites which live at the roots of the wool. The dipping mix is contained in a pit or tank with a sheer drop at one end and steps at the other. One by one the sheep are heaved, struggling, over the edge; as they swim for the steps they are pushed under by a man with a pole, to ensure thorough penetration of the wool. It is a strenuous business, and the men often finish up as wet as the sheep. Dipping is the last big job before the new season, and the gathering of the flock offers a fine opportunity to check the sheep and decide their fate. After two or three years of daily contact, having assisted at their birth and at their giving birth, the hill shepherd will have made most of his decisions already and the fate of nearly all the sheep is a foregone conclusion.



This chart shows the different stages of the stratified breeding system used in the British sheep industry which permits high-quality lamb to be produced in quantity from flocks that are easy and inexpensive to maintain

Two other combinations

1 Welsh Mt × Welsh Mt
↓
Welsh Mt × Border Leicester
↓
Welsh Half-bred × Hampshire Down
↓
lamb

2 Dalesbred × Dalesbred
↓
Dalesbred × Teeswater
↓
Masham × Texel
↓
lamb

SUMMER VISITING TREE PIPITS

Pipits are small, insect-eating birds related to wagtails but which look more like larks. Of all eight species occurring in Britain, the tree pipit is the only migrant. Some 100,000 pairs breed in Britain, though hardly any are seen in Ireland.

Right. The tree pipit's resemblance to a lark has earned it such local names as titlark, field lark, dusky lark and blood lark

Tree pipit (*Anthus trivialis*) Summer visitor to open country with trees Sexes alike 15cm (6in)

Below. A tree pipit nest on the ground. The bird never nests in trees, but derives its name from its habit of singing in trees. The song flight, too, begins from a tree or bush

Eight species of pipits can be found in Britain and Ireland. Five of these—the olive-backed, Pechora, red-throated, tawny and Richard's pipits—occur only as vagrants or rarities, most often in autumn. The remaining three—the meadow, rock and tree pipits—are all common breeding birds, but of these, the tree pipit is the only true migrant

What is a pipit? The name 'pipit' derives from the high-pitched squeaky calls that almost all pipits possess. Pipits are all small birds with slim bodies, finely pointed bills and jerky, flitting flight. Virtually all pipits are brown above with darker markings, and creamy below. They have dark brown streaks on the breast, flanks and around the throat, forming distinct moustachial stripes. Usually there is a creamy stripe above the eye, and the outer tail feathers are white

Pipits live in open country, and when on the ground they walk or run, but never hop. They live almost entirely on insects and larvae, caught on or just above the ground

The great similarity among the species of pipits causes real problems of identification for birdwatchers; not only the eight species seen in Britain, but all of the worldwide total of 34 pipit species are very similar in appearance

A brighter colour The tree pipit is typical of the genus *Anthus*, but is rather more colourful than its British relatives, having yellower, less olivaceous plumage than the meadow pipit and being much lighter in colour than the rock pipit It also has fewer but more prominent breast markings, and its legs are pinkish, whereas those of the meadow pipit are light brown and the rock pipit has grey legs.

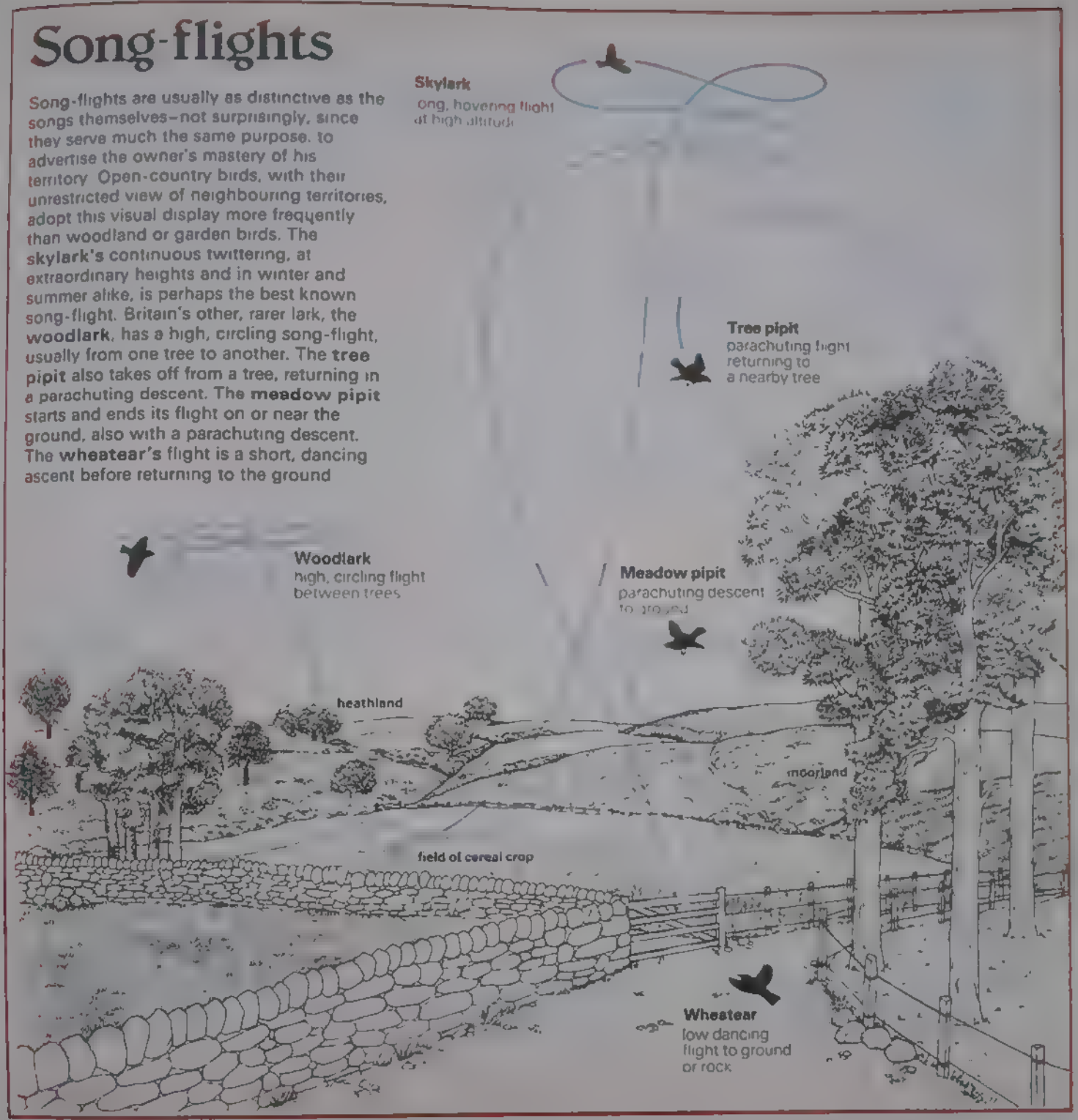
Song posts and habitats The tree pipit is the only pipit which regularly perches in trees Indeed, trees are almost essential to these birds, not for food or nesting cover (though they do fly into trees when disturbed), but to add a vertical component to their otherwise low-lying habitat. Trees provide high perches, from which they can launch into their characteristic and musical song-flight.

As well as song posts, tree pipits require open ground for feeding. Thus a variety of habitats may be suitable: heaths, clearings in woods, woodland edges, parkland, even mature woodland if it is sufficiently open. Mature forestry plantations are of little use, but if some old trees are left when the others are felled, subsequent plantations provide ideal conditions for a short while.

Singing males The tree pipit's breeding season starts in mid-April when the first birds (usually males, but quickly followed by the females) return from their wintering grounds south of the Sahara. Up until the end of July is the best time to listen for the male's musical,

Song-flights

Song-flights are usually as distinctive as the songs themselves—not surprisingly, since they serve much the same purpose, to advertise the owner's mastery of his territory. Open-country birds, with their unrestricted view of neighbouring territories, adopt this visual display more frequently than woodland or garden birds. The **skylark's** continuous twittering, at extraordinary heights and in winter and summer alike, is perhaps the best known song-flight. Britain's other, rarer lark, the **woodlark**, has a high, circling song-flight, usually from one tree to another. The **tree pipit** also takes off from a tree, returning in a parachuting descent. The **meadow pipit** starts and ends its flight on or near the ground, also with a parachuting descent. The **wheatear's** flight is a short, dancing ascent before returning to the ground

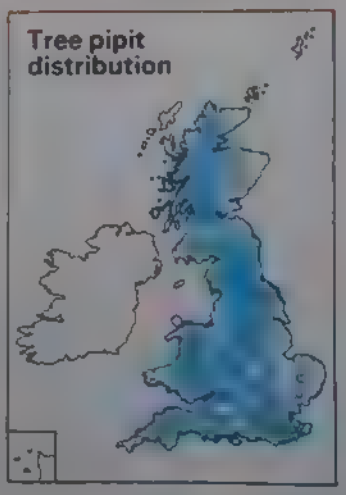


far-carrying and distinctive song—the final shrill 'seea-seea-seea' notes being the most memorable. This song, designed to warn other tree pipits that 'this territory is mine', is delivered in a shortened form from a perch, or in its full splendour in a song-flight.

Nests on the ground In its nesting details the tree pipit is typical of most pipits. Moss and dry grass comprise the main bulk of the nest, which is built by the female on the ground in a hollow sheltered by grass or other vegetation. Having lined the nest with finer grasses and hair, the female lays 4-6 eggs, noted for their variable colour: grey, brown or reddish with blotches and streaks or with more uniform speckles, often concentrated at one end.

Tree pipits are among over a dozen British birds known to be capable of rearing young cuckoos, both species being insectivores, but only about one per cent of nests are parasitised in this way.

Tree pipits in autumn In August and September song and habitat lose their usefulness as aids to identifying tree pipits, for at this time they become much quieter and leave their breeding territories in preparation for their migration flight south. However, they do have a call which, with practice and a good memory, you can learn to recognise. It is a short, high-pitched, rasping 'teez', much less squeaky than the meadow pipit's 'tsipp', and usually uttered in flight.



WOODY ROSE RELATIVES

Among the trees, shrubs and climbers of the rose family are some of our most important fruit crops, including apples, pears, plums and cherries.

Of all the plant families native to Britain the rose family, Rosaceae, contains by far the greatest number of woody species. Many are trees, usually small and growing to no more than 18m (60ft) tall, while others are shrubs varying from the low mat-forming mountain avens to taller sprawling climbers such as the wild roses. None of the trees forms pure woodland stands in the manner of oak or beech. Instead they occur in relatively small numbers alongside the dominant tree species.

To us the greatest importance of the group lies in the fruits, which are in many cases of great commercial importance as crops: apples, pears, cherries, plums and peaches all belong to the rose family. Among our native species the fruits of blackthorn (or sloes) and blackberry are a favourite food source for many species of birds and are also relished by man. Other species in the rose family are grown for their ornamental value, many of them originating outside the British Isles. The Japanese cherry is probably the best known of them

Family features Woody members of the rose family share several features in common with the herbaceous members such as meadowsweet and the cinquefoils. The leaves are almost always borne alternately along the shoot, and at the base of the leaves is a pair of leaf-like appendages called stipules. Some woody species, however, differ from the herbaceous ones in possessing thorns or hooks. In hawthorn and sloe, for example, the

Above: The flowers of dog rose (*Rosa canina*) may be either pink or white but they always have the five petals found on most members of the family. The syrup extracted from the hips is rich in vitamin C and played an important part in the diets of British people during the Second World War

Below: The smallest woody member of the rose family is mountain avens (*Dryas octopetala*), whose specific name indicates that its flowers have eight petals

terminal bud at the end of a branch is replaced by a sharp point–a thorn. Hooks are found on blackberries and wild roses, where they assist the plant in clambering over neighbouring vegetation.

The floral parts are arranged in fives: five petals surrounded by two separate whorls of five sepals making up the calyx and the epicalyx. The fruits come in a wide variety of shapes, sizes and forms. The blackberry, for instance, is an aggregate of many small one-seeded drupes, while the cherry is a large one-seeded drupe

Blackberries and raspberries The blackberry is a widespread species, inhabiting woods, hedges, waste places and heaths. Here, it is often very successful, encroaching on to new territory by germinating seeds or, more commonly, by its long arching branches, which root where their ends touch the ground The white or pinkish flowers appear from May through to the end of August, such an extensive flowering period giving rise to a long succession of fruit–from late summer to early autumn

The raspberry, so familiar as a cultivated soft fruit, is also a native plant of woods and heaths, especially in hilly districts. Many plants seen in the wild, however, are the result of birds spreading seeds from garden plants Wild raspberry flowers from early June until August, but it tends to ripen before blackberry–often as early as the end of June

The roses Four species of rose are commonly encountered in Britain. The dog rose the national symbol of England–bears delightfully perfumed, pink or white flowers The fruits are highly prized for they are the only wild fruit to support a national commercial enterprise: the production of rose hip syrup

The burnet rose, though less well known than the dog rose, is equally beautiful. It is a common sight near the coast, and inland on limestone heaths. The field rose is a much more robust plant, with white flowers that have little or no fragrance. This species is easily distinguished from the other native roses by its flowers which have long styles united to form a column. The fourth common native species is the sweet briar, which is similar to the dog rose though not as tall and vigorous

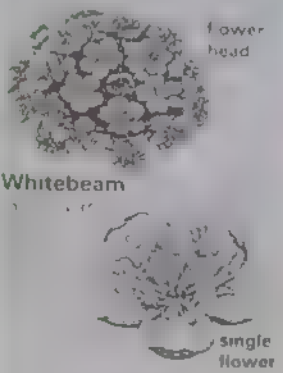
The hawthorns Britain has two native species of hawthorn, the common hawthorn and the Midland hawthorn, the former being much more frequent. Although the common hawthorn is often seen as a small tree, it occurs much more commonly as a hedgerow plant. The Midland hawthorn is more suited to woodlands, being much more tolerant of deep shade. It is confined mainly to southern England whereas the common species is found throughout the country. The two species differ in their flower and fruit structures. The Midland hawthorn has a flower with two styles and a fruit with two seeds, whereas the common hawthorn has one of each.

Apples and pears Many of the fruits we eat are cultivated forms of plants that are native to Britain and still grow in the wild here. The wild apple, better known as the crab apple, is a large shrub or small tree with a dense rounded crown. The familiar round fruits are only 2cm (1in) in diameter. It is said that there are two types: those that hang from the tree, which have a sharp taste, and those that stand more or less erect on their stalks, which have a comparatively sweet taste.

The common pear has a pyramidal outline and can reach a height of 15m (50ft). The fruits taste very bitter, hence the tree's alternative common name of choke pear.

Flower structures

Dog rose
(*Rosa canina*



A whitebeam's flowers are borne in a cluster (technically called a corymb) but individually each flower has a structure very similar to that of a rose flower

Above right: Ripening fruits of blackberry (*Rubus fruticosus*). At least 400 distinct micro-species of this plant have been recognised in Britain

Below: The pale grey-green of whitebeams in flower

Woody members of the rose family

Cherries and blackthorn Cherries, peaches, plums and almonds are all members of a single large genus called *Prunus*. One of the parents of our cultivated cherries is the wild cherry, a native species of woods and hedgerows. Sometimes called the gean, the crown of this tree becomes covered in April and May with pure white flowers. By the autumn these have developed into dark red cherries.

Another native species in this genus is the bird cherry, cultivated forms of which are often grown in this country as ornamentals. Its flowers are smaller than those of the wild cherry and they are borne on drooping or spreading racemes up to 15cm (6in) long.

The third familiar native in this genus is the blackthorn, one of our most conspicuous hedgerow shrubs. In early March before its leaves appear, masses of white flowers seem to signal the start of spring. But this is also a time of late frosts and bitter winds, so the period is

Above: An orchard of bramley apples in blossom Today's cultivated apples are descended from our native wild apple

Opposite right: Blackthorn (*Prunus spinosa*) may be one of the parents of our modern plums and damsons

Far right. Rowan (*Sorbus aucuparia*) in fruit

Key to species
Shown below are the flowers, fruits and shoots of some common woody members of the rose family native to the British Isles.
1 Dog rose (*Rosa canina*).
2 Field rose (*Rosa arvensis*).
3 Burnet rose (*Rosa pimpinellifolia*)
4 Shrubby cinquefoil (*Potentilla fruticosa*)
5 Wild service tree (*Sorbus torminalis*)
6 Rowan (*Sorbus aucuparia*)
7 Whitebeam (*Sorbus aria*)
8 Blackthorn (*Prunus spinosa*)
9 Mountain avens (*Dryas octopetala*)
10 Hawthorn (*Crataegus monogyna*)
11 Midland hawthorn (*Crataegus oxycantha*)
12 Wild cotoneaster (*Cotoneaster integerrimus*)
13 Wild apple (*Malus sylvestris*)
14 Common pear (*Pyrus communis*)

often known as a 'blackthorn winter'

Whitebeams and rowans One of the largest native genera in the rose family is *Sorbus*, with 20 recognised species native to Britain. Of these, only three are common. The rowan, or mountain ash, is a charming small tree growing to a height of 15m (50ft) with a narrow crown and ascending branches. Each leaf is composed of nine pinnately arranged leaflets (four along each side of the stalk and a leaflet at the end). Its brilliant orange berries are a great attraction to certain birds, though a few manage to escape their ravages and remain on the bare twigs until January

The other two common species are the whitebeam and the wild service tree The former has hairy young twigs and a distinctly white undersurface to the leaves, while the latter has leaves with a green undersurface

The remaining species in the genus *Sorbus* are endemic to the British Isles (ie. found nowhere else in the world) and form very local populations Two, for example, are confined to the Isle of Arran off the west coast of Scotland, where they grow on the steep granite streamsides

Endangered species With such a large family as the Rosaceae, it is not surprising that some of its members are very rare in the wild. The two rarest are shrubby cinquefoil and wild cotoneaster, both of which have been long over-collected by both botanists and horticulturists. Shrubby cinquefoil is a deciduous shrub up to 1m (3ft) tall with very pretty yellow flowers appearing in June and July There are about 12 populations left in Britain and Ireland. Wild cotoneaster is also a deciduous shrub. Its flowers are pale pink and its berries red. There are only five plants left in the wild in Britain

Another rare member of the rose family is confined to the highest mountains of northern England, Scotland and Ireland. This is mountain avens, the lowest-growing woody member in the family. It forms large carpets of glossy dark green foliage and the white flowers are borne singly on stalks about 8cm (3in) long. As these flowers mature, the styles become elongated into long feathery awns

WHAT IS A WORM?

To most people, the word worm conveys distinctly unattractive prospects: at best the familiar garden earthworm, at worst some scarcely mentionable internal parasite.

It is difficult to answer the question 'what is a worm' in a clear and concise way, for there are many kinds of worm in the animal kingdom Worms come in all sizes, from the microscopic to the 5m (16ft) long ribbon worm *Lineus longissimus*; they assume many life-styles, ranging from free life in the ocean depths to parasitism of other animals and plants which live on land. Some are important medical and agricultural pests, while others are of academic interest only

For all their diversity, worms have some important features in common. These are bilateral symmetry, an anterior head bearing at least a primitive 'brain' and rudimentary sense organs, and a lack of limbs. All live in moist, if not fully aquatic environments, or they are parasites

Zoologists classify animals according to their evolutionary origins, so that all animals with a common evolutionary origin are classified in the same phylum. For many years the evolutionary origins of worms were poorly understood. Now we realise that worms range over various levels of organisation from simple to complex indeed, there are even animals among the insects and vertebrates which are called worms because of their appearance, but are not really worms at all.

The simplest worms These are the flatworms, phylum Platyhelminthes, which have leaf-like bodies made up of three cell layers and no body cavity. Structurally they are simple with rudimentary heads, simple guts (where present) in which the mouth serves as the anus as well, and elementary nervous and excretory systems While many flatworms

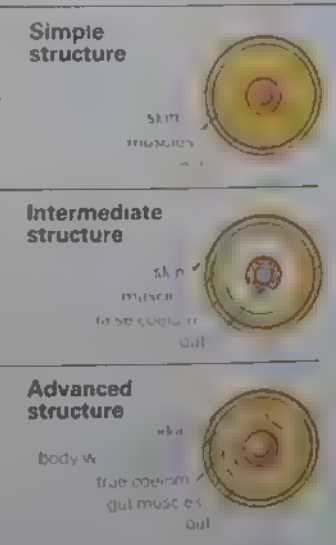
Key to table (below)

Lower groups
- minor importance
- major importance

Higher groups
- minor importance
- [illegible]
- non-worms belonging to a phylum that is better known [illegible]

The world of worms

	Animal groups	No. of species		Description or common name
1	Platyhelminthes	14 700		Turbellarians, flukes, tapeworms
2	Nemertea	900		Ribbon worms
3	Acanthocephala	600		Minor parasitic group
4	Gastrotricha	200		Microscopic worms
5	Kinorhyncha	120		Microscopic worms
6	Nematoda	12 000–500,000		Roundworms, many parasitic
7	Nematomorpha	100		Minor group, parasitic as larva
8	Priapulida	10		Sea-bed dwellers
9	Mollusca	107,250		Shipworms, aplacophorans
10	Pogonophora	100		Sea-bed dwellers
11	Annelida	9,300		Polychaetes, eg lugworms, oligochaetes, eg earthworms, hirudines, eg leeches
12	Sipuncula	250		Sea-bed dwellers
13	Echiura	150		Sea-bed burrowers
14	Arthropoda	850,000		Immature insects eg bloodworms, wireworms
15	Chaetognatha	50		Arrow worms
16	Hemichordata	80		Acorn worms
17	Chordata	44,000		Slow-worms



Advanced animals possess a coelom or body cavity. The presence of a coelom separates gut and body muscles so that each can specialise in its function

(order Turbellaria) are free-living, gliding over pond, river and sea beds by the actions of a multitude of beating cilia, the most remarkable ones are the parasitic flukes and tapeworms. A few flukes live as external parasites but most are internal parasites like the liver fluke of sheep and cattle

More advanced The ribbon worms (phylum Nemertea) resemble the flatworms in again having three cell layers and no body cavity, but they are more advanced in possessing a better defined head. They possess eyes as well as chemosensory organs, and a mouth opening through which, or close to which, a proboscis may be everted. There is a 'one way gut' with an anus at the rear and a blood system. The body is generally flat and often extremely long; *Lineus longissimus* may reach 5m (16ft) in length. The proboscis is used to trap the prey, immobilise it and draw it to the mouth

One group of nemerteans lives as external parasites of other invertebrates, such as bivalves. Ribbon worms are almost all marine, but a few live in fresh water or damp soil These worms are generally of little economic or ecological importance, although they are more common than is frequently imagined They are often found burrowing in sand and mud on the shore or in cracks and crevices in the rocks

Above: This leaf-shaped marine worm is a member of the primitive phylum of flatworms

Opposite page left: The peacock worm is a tube-dweller with many advanced features, such as this fan of feeding tentacles It belongs to the phylum of annelids

Left. Ribbon worms like this are a primitive phylum but have some advanced features, such as eyes

Below: Another member of the annelid phylum, this paddle worm derives its name from the many paddle-like appendages on its body

Ecologically important In the roundworms, phylum Nematoda, we find a conspicuous change in the body structure. Here a fluid-filled cavity, technically known as a false coelom (pronounced 'seal'em'), separates the muscles of the body wall from the thin-walled gut. The roundworms use the fluid pressure generated in the false coelom to inflate their bodies and provide a fluid 'skeleton', against which the muscles act.

Roundworms are a major animal group, their species cannot be fully counted for much is yet to be learnt about their classification Some people estimate the total number of roundworm species to be about 12,000 but others place the figure at about half a million The latter estimate is based on the assumption that almost all other multicelled animals, as well as many plants, probably have specific nematode parasites.

Nematodes as parasites are horticultural, agricultural, veterinary and medical pests Others live free in soil, freshwater and marine habitats. They range in size from microscopic, like the nematodes that live in cider vinegar, to the 18-20cm (7-8in) long gut parasites of man and pigs.

Higher worms The phylum Annelida contains the most familiar worms in the animal kingdom. These are the earthworms, bristleworms and leeches. They are regarded as 'higher' worms by zoologists because they have evolved a true coelom which separates the muscles of the body wall (which are responsible for locomotion), from the muscles of the gut (which are important in digestion). This means that locomotion and gastric activity can take place independently.

Their bodies are also divided into a series of structural segments, the number being reasonably constant according to the species. Each of these segments is a permanent feature of the adult worm, not a transient development as in the tapeworms.

CRAIGELLACHIE BIRCHWOOD

Craigellachie Birchwood, a National Nature Reserve near Aviemore in Scotland, is of great interest for the valuable contrast it provides to the mainly pine woodland of the Cairngorms. There is no pure birch woodland to equal it in the area.

Craigellachie birchwood lies immediately to the west of the village of Aviemore, some 45km (28 miles) south of Inverness, and covers an area of 260ha (642 acres), of which 101ha (250 acres) are birch, the remainder being open moorland on higher ground above 380m (1250ft). The whole area is of exceptional biological interest, particularly because

Above. Silver birches in spring leaf on the slopes of Craigellachie. This species is the most common in the wood, but downy or hairy birch is also found

Right: Bog bean flourishes on the loch in the Reserve.

of its insect fauna, especially the moths, which include such species as the Kentish glory, the Rannoch sprawler and the great brocade.

The Nature Trail Because of major road improvements in 1980, the entrance to the reserve is now by tunnel. The points of entry are from either the Aviemore Castle Centre Complex or by a track from the main road which bypasses the youth hostel. The nature trail starts from the tunnel.

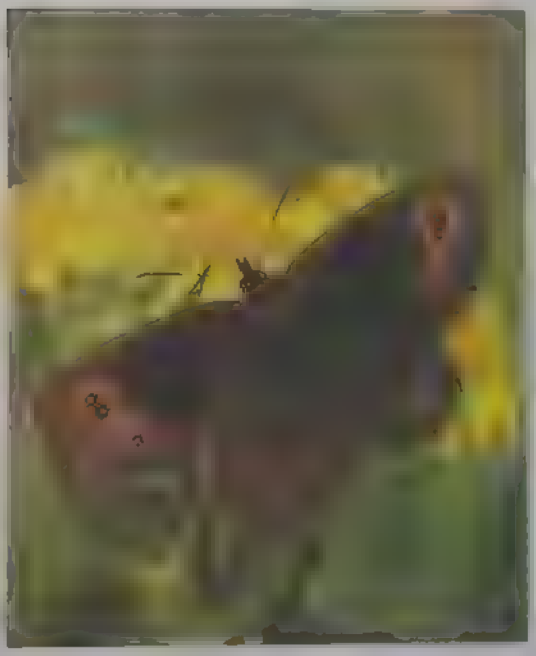
One of the first major points of interest is Loch Puladdern. This attractive tree-fringed loch, one of three areas of open water on the reserve, is fairly shallow, with a maximum depth of 3m (10ft). During road construction in 1980, the remains of an old oak tree were dredged up: carbon dating claims the age to be 2000 years. This raises the question, was Craigellachie at one time an oakwood? Before road construction, alder trees lined the east bank. Now only small saplings can be seen at the northern end of the loch, attempting to re-establish themselves. Here, where the stream runs into the loch, a fan of vegetation spreads outwards on the silty bottom. The thickest part is a large mass of bottle sedge, an erect plant which bears conspicuous fruiting spikes in July and August. Near the deeper water grows bog bean, with trifoliate leaves and whitish fringed flowers. The lesser spearwort, a straggling plant with yellow flowers and lance shaped leaves, grows where the stream enters the loch

Craigellachie Rock This name, derived from Gaelic, means 'rock of the stony place' Rising vertically to a height of 91m (300ft), the rock mass towers above the loch slightly to the west, and is home to hundreds of nesting jackdaws. During sunrise the air is vibrant with wingbeats and raucous calls as these birds go in search of food. At first sight, the visitor might believe that jackdaws are the only inhabitants of the rock, but a few minutes spent here may reveal a peregrine falcon, a rare bird that was at one time persecuted and shot but is now protected by law.

Above: The common sandpiper has been known to nest on the shores of the loch

Right: A Scotch argus butterfly—this species can be seen in large numbers on sunny days in July and August. Widespread in Scotland, it has a distinct preference for birchwoods The caterpillars hatch in September and feed during the day, they hibernate throughout the winter, then resume feeding in spring, pupating in July and emerging two weeks later

Below: Craigellachie's first red squirrel was recorded near the reservoir in August 1983



The trail now starts to ascend slowly on boulder steps towards the first observation platform, on either side of which both species of birch can be seen. Silver birch, sometimes called pendulous or weeping birch (*Betula pendula*), is the most common. It is easily recognisable by the pendulous habit of its branches and its warty twigs; it grows fast and is relatively short-lived. It helps to improve conditions for the succession of plants and trees which eventually follow. The downy or hairy birch (*Betula pubescens*) is more bushy and its twigs are covered in small hairs. Neither species casts a heavy shade, hence ground vegetation flourishes, providing important habitats for many birds, mammals and plants. It is here that chaffinches, wrens, coal tits, long-tailed tits, blue tits and great tits can be seen among the branches of the trees.

The visitor may catch glimpses of the willow warbler which is a summer visitor to these parts, but it is more likely to be heard than seen. A small, quiet but abundant visitor, its plumage is olive-brown and the call, a plaintive 'too-eet', is similar to that of the chaffinch, but is softer and carries further

The observation platforms From the observation platform, which faces east, panoramic views of the Spey Valley can be seen. The eye can follow the River Spey for several miles as it meanders in a north-easterly direction towards the sea.

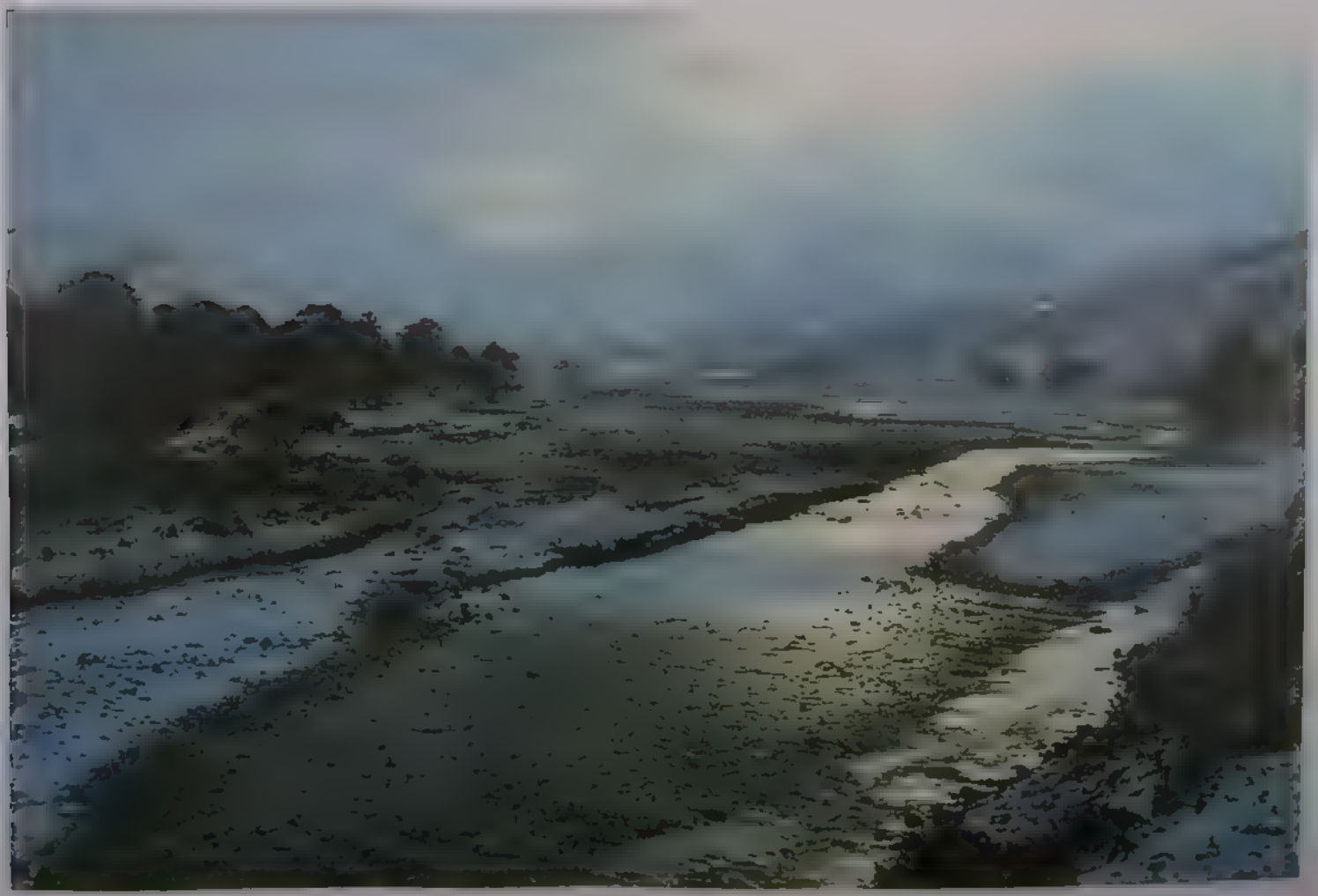
At this point, the visitor has the choice of either a short trail or a long trail. The long trail takes in the higher contours of the hill, and duck-boarding is used to ford the wetter areas On both sides of the boarding bog asphodel blooms in profusion in summer–a small but charming plant with deep orange flowers. Another attractive plant is the globe flower, which is about 2.5cm (1in) across and resembles a full moon. May and June are the best times for seeing these plants. Orchids abound, notably the heath spotted and the northern marsh orchids The common sundew and the butterwort, both insectivorous plants, also grow here, favouring the wetter ground. On a damp day the visitor may be aware of a strong, sweet smell which comes from an aromatic shrub called bog myrtle

Leaving the wetter areas, the trail now runs level on stony ground until it reaches the next platform. It is on these dry areas before the platform that the chanterelle fungus can be found. In a good year the ground is covered with these funnel-shaped fungi. Large numbers of edible boletus species share the same habitat. This is a large fungus, 5-10cm (2-4in) across the dome-shaped cap and generally yellowish-brown in colour

On arriving at the second observation platform and looking south-east, the vista can

Above: A golden eagle and its chick. The golden eagle is a spectacular sight over the Reserve, soaring as it uses the updraught from the ridge and constantly gaining height

Below: Magnificent views of the Cairngorms can be seen from Craigellachie



Opposite right A roe buck in velvet, prior to fraying. Where the duckboarding passes through arches of overhanging birch, stand quietly and scan the hillside– you may spot roe deer. A sharp barking noise means you have been detected. The roe deer's ability to scent danger is phenomenal, as its sense of smell is one hundred times greater than that of man. Small birch saplings standing alone are favoured by the bucks as fraying or scent posts
During winter, when grazing on the high ground is scarce, red deer descend to feed on the lush herbage around the boarding. In late evening or early morning, 15 or 20 red deer are not uncommon.

only be described as breathtaking. Beyond the village of Aviemore the wide valley provides fertile farmland for sheep and beef cattle. On slightly higher ground are extensive forests, managed both privately and by the Forestry Commission. Most of these forests are of Scots pine, and individual trees reach ages of 250 to 300 years. The whole Cairngorm mountain range can be seen at a glance. The visitor can look up into the famous Lairig Ghru pass which runs from Spey-side to Braemar, a distance of 40km (25 miles), and is used extensively by hill-walkers throughout the year. It is from this point that the osprey may occasionally be seen, keeping a watchful eye on the Spey below. As it glides along, at times only 30m (100ft) above the water, the bird will suddenly dive out of sight and reappear further downstream carrying its catch, probably a sea trout. Below the platform the ground dips downhill and is grass-covered, interspersed with bracken and

Above: A map of Craigellachie Nature Reserve, showing the path of the nature trail and some places of interest along the route.

Right: The chanterelle mushroom can be found near observation platform 2. Yellow in colour and with a smell akin to that of apricots, this fungus measures from 2.5cm to 8cm (1-3in) across. When it is properly cooked, the chanterelle is second to none in flavour.

heather. On a sunny day during July or August the Scotch argus butterfly can be seen here in large numbers

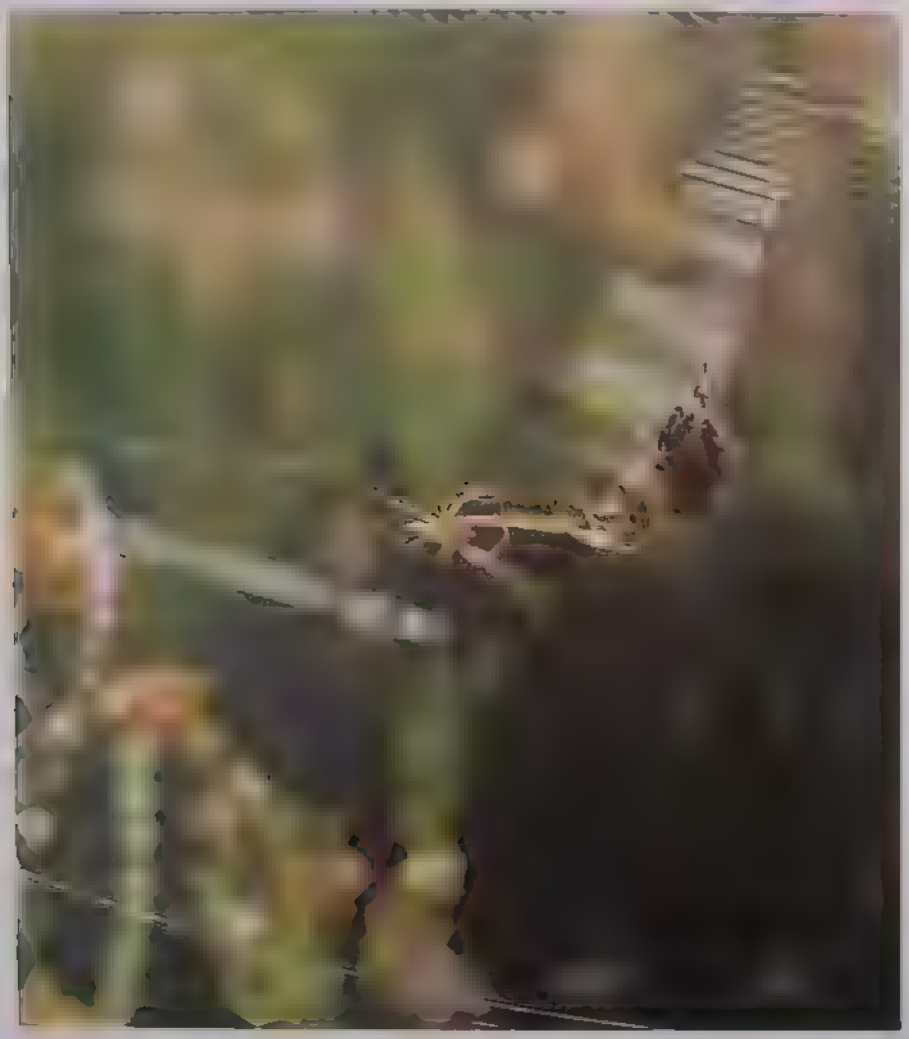
There is an experimental enclosure near the platform which, through lack of visitor pressure, is relatively undisturbed. The great spotted woodpecker makes full use of this and has been known to nest in one of the decaying trees

The old reservoir Leaving the last platform behind, the trail now begins to descend along a very stony road which is used occasionally by the Water Board for access to the reservoir As the road levels off, the trail takes a turn to the right, passing the old reservoir. On the northern side a small burn feeds the reservoir, continually depositing a fine layer of silt which forms a spongy bed on which grows the common rush. A great variety of plant life occurs in and around the shore. The water horsetail is easily recognisable by its erect, jointed stem. The large, golden-ringed dragonfly can be seen as it hawks along in a predetermined flight path, vigorously threatening any intruders. Another dragonfly is the four-spotted libellula, brownish in colour, with a black tip to its body. This species, too, is a strong flier and is on the wing from mid-May to August.

Most of the water surface is covered with two species of pondweed, the broad-leaved pondweed and the bog pondweed. Various water birds frequent the reservoir, including mallard, wigeon, goldeneye and occasionally teal. A regular visitor to the reservoir is the heron. This large wader can be seen standing in the shallower water while looking for the small trout or frogs which form its staple diet. From the reservoir, looking west towards the skyline, the early morning visitor may see a buzzard working its way along the ridge. Finally, just below the old reservoir, the nature trail rejoins the start, and the exit is via the same tunnel.

THE ANTICS OF SPIDER COURTSHIP

Spider courtship can be a complex and lengthy affair as the smaller, more submissive male may spend an entire day attempting to approach, excite and seduce the female who, initially, is more likely to regard him as a potential meal rather than a mate.



Above: Courtship is not easy for a male garden spider. On occasions he has been watched for an entire day repeatedly tweaking the web and advancing towards the female, only to be met each time by a fierce onslaught. Swinging down out of the way on a thread fixed to some nearby vegetation he then pauses, climbs up and tries again and again until eventually he succeeds in coaxing her on to the mating thread where she at last becomes submissive

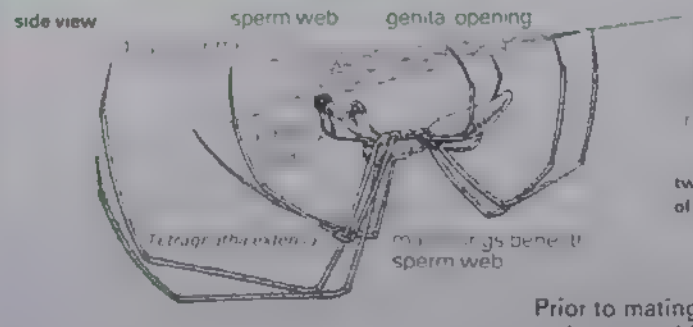
Courtship is a ritualised form of behaviour preparatory to mating, and it is only very rarely that animal species mate without such preliminaries between the sexes. The courtship of spiders includes behaviour which is decidedly advanced compared with most other invertebrates. Much of it involves signals for identification but the spiders also exhibit types of behaviour which might be described in anthropomorphic terms as extrovert, seductive, devious or pre-emptive. For the male spider this interaction is essential if he is to avoid being mistaken for prey. For the female, a considerably larger individual, it helps to pacify her predatory instinct and provides the stimulation necessary for copulation.

Sperm induction In most species it is the male that actively seeks the female, although the female may have made some effort by emitting chemical signals (pheromones) into the air or on to silk drag-lines trailed behind her which help the male to track her down.

On becoming adult, the male spider usually loses interest in prey, leaves his web or retreat and spins a tiny sperm web. On to this he ejaculates a drop of semen which he draws into organs in his palpi. He then goes in search of a partner and attempts to inject the semen into her genital apertures.

The entire exchange of information between the two sexes can be highly complex, with successive or simultaneous actions and signals including pheromones, sounds, vibrations, visual effects and tactile stimulations. For each species the combined effect is unique so that individuals can find a suitable mate from their own species.

Courting on a web Spider courtship techniques may be broadly grouped depending on whether they are those of web-builders, clear sighted hunters, or poor sighted hunters. Among the web-builders (families Araneidae, Theridiidae and Agelenidae) courtship usually involves the male jerking and vibrating the web threads by tugging with his legs and drumming with his palps and, when the female has permitted his approach, stroking her body. The males are not always successful though, and in the case of the garden spider



The male prepares for mating

Prior to mating the male spins a tiny sperm web on to which he ejaculates a drop of semen from his genital opening. He then draws the liquid into his palpal organs and goes in search of a female

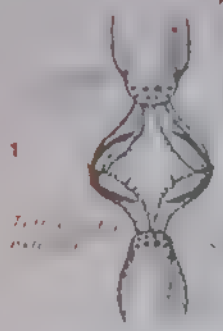
battle-scarred males are sometimes seen towards the end of the mating season with only three legs left

Males of the ubiquitous *Meta segmenta* wait in the outskirts of the female's web until she is busy with an insect before approaching Hours may pass without either making a move, but as soon as an insect is caught in the web and the female begins to feed the male advances and strokes her with out-stretched legs. They grapple, then break, and while she returns to the meal he trails a mating thread over her ready to begin his vibrations which, if he is lucky, will eventually interest her in mating

Many web-spinners have stridulatory organs on their body which produce acoustic signals unique to each species. *Zygiella notata*, a species common under the eaves of sheds, is one such example and so is the small *Dictyna arundinacea* and the house spiders *Tegenaria parietina* and *Tegenaria atrica*

Two approaches to courtship

Unlike most of the web-building spiders the male of *Tetragnatha extensa* (1) makes a bold approach towards the female, seizing her open fangs with his own in a grip that prevents her from biting him any further The male buzzing spider (2) is the one British species that produces a sound during courtship clearly audible to humans He makes this sound by simultaneously vibrating his abdomen against the femoral segments of his last pair of legs, and his first pair of legs—this aids species identification



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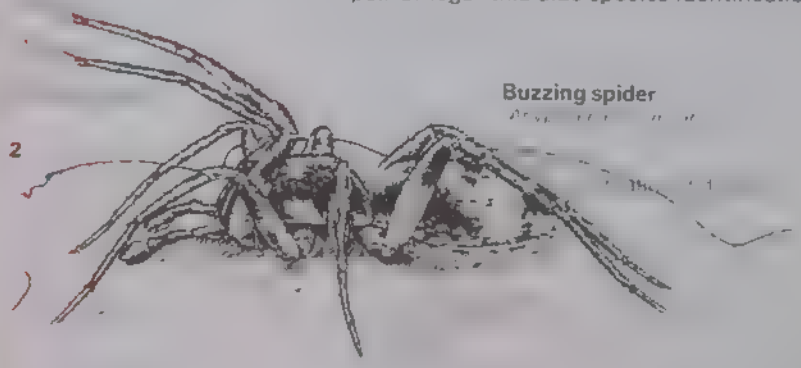


Buzzing spider

2

Left: The male *Xysticus* spider binds his partner down with silk, but she can break free, so the purpose may simply be to improve stability during copulation

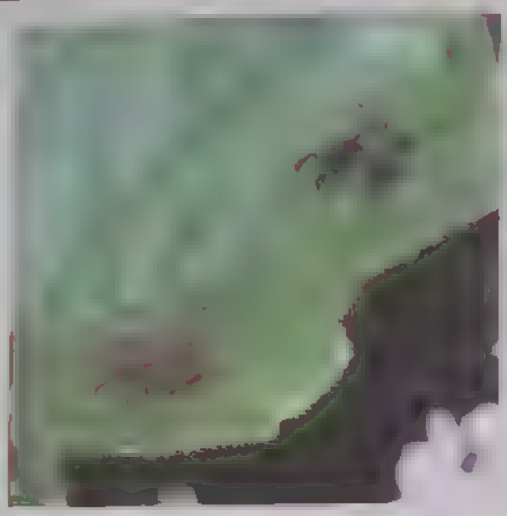
Below: Look carefully at this picture and you will see a pair of *Tetragnatha extensa* spiders. The male (right) is gripping the female's fangs (left) with his own so that she cannot bite him

Visual performers Among clear-sighted hunting spiders the males often perform a visual display before approaching the female Wolf spiders (Lycosidae) and lynx spiders (Oxyopidae) wave their palps up and down or vibrate them The common wolf spider's courtship involves an elaborate semaphore-type display in which the male stands as tall as possible and holds his black palps out sideways, alternately raising one and lowering the other as he slowly advances on the female

By far the most extrovert courtship displays are performed by the jumping spiders (Salticidae), known for their highly developed eyesight. In a most elaborate dance the males perform various antics and show off their colour pattern to the best effect. A fine example is the male jumping spider *Aelurillus insignitus*, which, in contrast to the drably coloured female, has a black and white abdomen. Holding his body at an angle with the rear end touching the ground, the male lifts his first pair of legs (which are black with a striking bright yellow segment) as high overhead as possible and then down again. Repeating this hypnotic movement he advances towards the female with jerky steps, as long as she is not hostile

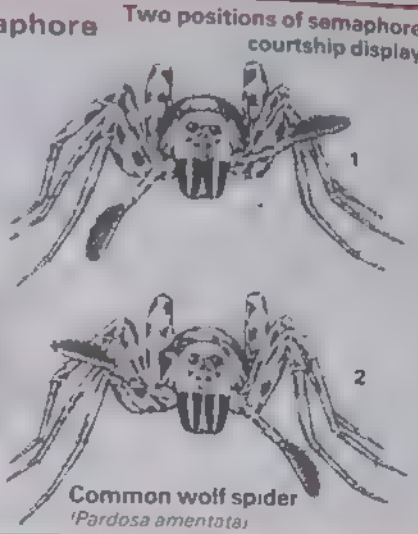
The large semi-aquatic raft spider has a lycosid-like courtship, the male stretching out his palps and rapidly vibrating his front legs, but he often waits until the female is eating something before advancing.

In the much more common *Pisaura mi-*



Luring the female with semaphore

Clear-sighted hunting spiders perform elaborate visual displays during courtship. In the case of the common wolf spider (left) the male embarks on a semaphore type display in which he holds his black palps out sideways, alternately raising one and lowering the other He repeats these movements as he slowly advances towards the female until she either moves back or drives him away. If he persists however, she should become excited



rabilis the male first catches an insect, wraps it in silk, and then hands it to his partner before attempting to mate. The great arachnologist, WS Bristowe, describes how the male *Pisaura* sometimes cheats by wrapping up the empty carcase of a fly, or even by running away with the wedding gift at the end of the mating ceremony

Courting in the dark Short sighted hunting spiders (families Dysderidae, Gnaphosidae and Thomisidae) tend to walk about in a groping fashion with their forelegs stretched out ahead, and frequently their courtship is extremely brief. Unable to introduce themselves by web vibrations or visual signals, there is an immediate and frenzied interplay of legs when the sexes meet, the male attempting to reach the mating position while still using tactile stimulation.

Many such species, like the woodlouse spider, spend much time in closed silken cells and this is where the male usually finds a female. On arriving at the silken cell the male spends some time making an introduction by rubbing the silk with quivering legs. He then rips open the cell with his large fangs, places his first two pairs of legs through the hole and walks in. The female meets him, brandishing her gaping fangs, but as he taps and strokes her body with extended legs she quietens down.

Above: *Meta segmenta* males only approach the females when they are busy feeding

Below A jumping spider, the most extrovert of seducers

In the rather large and fierce *Drassodes lapidosus*, the male reaches maturity earlier than the female and then takes possession of an immature female by enclosing her in a silken cell and mating with her immediately after her final moult, before she gains full strength. *Micrommata virescens* and several of the crab spider males seize the female by a leg and hold on until her struggle ceases or the counter attack becomes too dangerous for them to proceed.

Competing males Encounters between male spiders are frequent, especially where population density is high, as with wolf spiders on the woodland floor. When two male wolf spiders meet in the presence of a female they assume specific threat postures and may begin to fight. A dominant male (established in previous fights) is likely to be the winner and it is he who turns his attentions to the female, circling around her and waving his palps in a courtship ritual.

INSECTS AT THE WEATHER'S MERCY

Because of their small size and brief lives, insects are very much at the mercy of the elements. In a country like Britain, where the weather is so unpredictable that no two years are alike, many species have adapted to cope with these difficulties.

The geographical position of the British Isles between the wet Atlantic airstream and the Continental land masses, gives us an ever changing and unpredictable weather pattern. Most plants and animals of temperate regions such as ours are regulated by their environment and particularly by the weather, but it is with the small cold-blooded creatures like insects that the day-to-day weather has its greatest impact. The effect of weather on insects may be direct or indirect (by affecting the foodplants the lives of insects are influenced), but the results can be very noticeable, leading to 'good' or 'bad' seasons in the species.

Much still remains to be discovered about

Above: The comma butterfly takes advantage of warm, early spring days to seek a mate and start breeding. If it is a cold, dull or wet spring, however, the reproduction process can be hindered and the number of comma butterflies severely reduced, making it a bad year for the species

Left. For short-lived insects like the delicate mayflies, which need suitable conditions to mate and lay their eggs, the weather is important. On average they are successful insects but a heavy shower or strong winds can be disastrous small tarns in the Lake District are often strewn with dead mayflies after bad weather—vivid testimony to the fragility of insect life

Below: The transformation from nymphs to adults in the meadow grasshopper is influenced greatly by weather conditions, and can occur at any time between June and August, depending on when the weather is warmest

the effect of weather on insects but the research already carried out has revealed some interesting facts. Here we examine some of the day-to-day effects of the weather on insects.

Basking in the sun Air temperatures and sunshine are the most important features of weather as far as an insect is concerned. Like all life forms, insects function better at higher temperatures, and many need to raise their body temperatures to 20°-30°C (68°-86 F) before they can move around and fly freely.

On cold, dull days most insects are inactive, resting on vegetation or hiding away. A cold, sunny day, however, is beneficial for those insects that bask. Such a day in early spring will bring out clusters of ladybirds. These beetles, like many other insects, use sunshine to warm up sufficiently so they can crawl about and feed. By basking they can hasten the transition from their reduced winter metabolism to the frantic physiological activity of reproduction.

Butterflies, such as the comma, also take advantage of the early spring days to seek out a mate. If the spring is cool, dull or wet, however, many species do not get the start they need—a setback which may continue into the following year as well.

On hot sunny days insects are able to balance their body temperature at a level preferred by the particular species. The marsh fritillary caterpillar, for instance, has a preferred body temperature of 35 C (95 F) when basking, but the speckled wood adult tries to maintain its body temperature at 28°C (82°F).

A garden at the height of summer literally hums with insect activity on such warm sunny days. Day-flying insects appear to make the most of this sunshine, packing as much as possible into those fleeting days. This grasping of opportunity is an essential way of life for short-lived species which must mate and reproduce in just a few days before they die

Hazards of egg-laying We usually assess how successful an insect species is by measuring whether it is common or rare in a particular year. Weather acts upon all stages of insect life history, subtly influencing their success in reaching adulthood.

On average, the most important and vulnerable stage of an insect's life is when it is an egg. The number of eggs laid influences the number of adults in the following generation. In the populations of several butterfly species which have been studied in detail, the failure of females to lay all their eggs is one of the major factors influencing numbers. Most female orange-tips, meadow browns, wood whites and marsh fritillaries die before laying more than about half of their total egg load. The main reason for this is that the females do not have the opportunity to lay all their eggs because of patchy weather conditions.

Even before egg-laying can begin the insects

have to mate - behaviour that requires both partners to be fully active and which must therefore take place in warmth and sunshine a sunny day after a week of dull, cool weather often brings out large numbers of mating insects.

Selecting a site Once the gamble of mating has succeeded the female must choose a suitable site for her eggs. This is a time and energy consuming process, so she needs to be fully active. The characteristic patchiness of British weather usually means that female butterflies can lay their eggs during only a small fraction of the daylight hours. One way around this problem is to lay several batches of eggs instead of individual eggs, thus economically using the time spent in searching. Such a practice is especially apparent among insects which lay their eggs in the early spring.

Dull or cold weather may also influence the pattern of egg distribution. In normal years the brown hairstreak butterfly lays her eggs individually on hawthorn twigs, but in years when poor weather prevails at egg-laying time the eggs have been found clustered together or laid in pairs. This is presumably because the females do not readily fly in dull weather; instead they crawl up and down the twigs to lay their eggs.

Caterpillars and pupae Weather conditions can also interfere during an insect's larval and pupal stage. In early spring the winter moth caterpillars hatch from their eggs high up in oak trees. They can then redistribute themselves by spinning a strand of silk and floating on it to neighbouring trees and bushes. All trees have their own particular time for leaf-burst, usually controlled by changes in day length and air temperature. Since the caterpillars' survival depends on whether they reach the bursting leaf-bud in time (this species feeds on bursting leaf-buds only), the weather in spring greatly determines their prospects.

Another way in which the weather determines insect survival is by influencing the time spent in a particular stage. The development rate of all insect larvae and pupae is affected by temperature, and a cool period extends the time spent as larvae or pupae. This in turn means that the larvae and pupae are about for longer and so they are more likely to be found by birds and eaten.

Internal generators The dependence of insects on weather is not universal. Social bees and wasps are able to control their own environment deep down in their nest, and an insect such as the bumble bee can warm itself up by contracting its wing muscles rapidly after disconnecting them from the wings - a bumble bee seen sitting on a flower and simultaneously buzzing is doing just this. These ways of circumventing weather enable bees to gather nectar and pollen when other insects are 'grounded' due to adverse weather conditions.

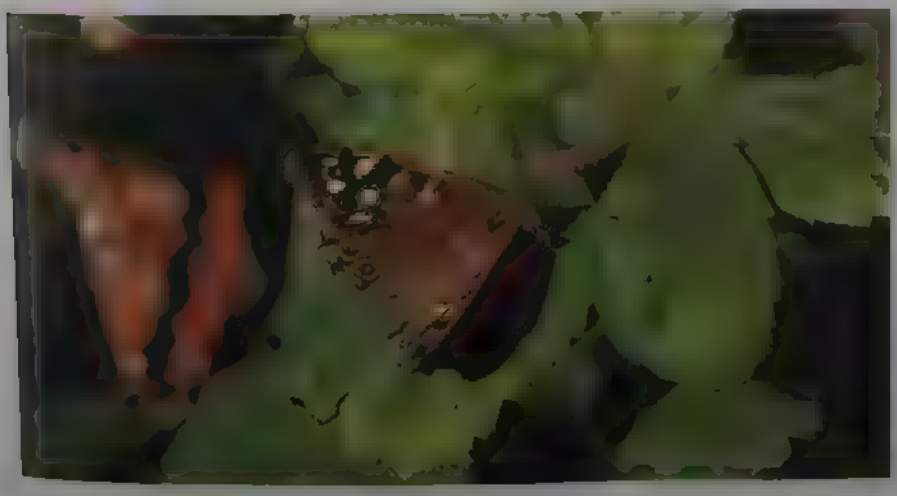
Misfortunes of the marsh fritillary

The marsh fritillary is parasitised by a tiny wasp. *Apanteles* [illegible] (right) in spring they spin a cocoon around the dying caterpillar. Here they pupate and develop into adult wasps which [illegible] to parasitise [illegible] develop slowly and when the adults emerge there are no caterpillars left to parasitise. If there is a dull mild spell, however, both the parasites and caterpillars are held back and the wasps emerge to find plenty of hosts. The weather is thus crucial and may mean the difference between 10% and 90% parasitism of marsh fritillary caterpillars with obvious effects upon adult numbers.

Right: A cold and sunny day in early spring brings out clusters of ladybirds, such as these *Anisostica 19-punctata*. These beetles use the sunshine to warm up sufficiently to crawl about and feed. By basking they can hasten the change-over from winter metabolism to the frantic physiological activity of egg maturation and reproduction.

Left: Egg-laying is a time and energy consuming process in which the female needs to be fully active, hence it can only be done during the few hours of daylight. Insects like this pied shield bug, which lay their eggs in early spring, have only a few hours of daylight so they lay them in batches to lessen the time spent looking for sites.

Below: The speckled wood has adapted to the vagaries of our climate by having more than one brood a year which can pass the winter either as torpid caterpillars or as hibernating chrysalids, depending on the summer's weather.



BIRDS AND CHANGE ON THE FARM

Agricultural change creates a 'swings and roundabouts' effect on farmland birds: some species suffer, while others certainly benefit.

Above: Even in the 1960s, after the combine harvester had come into its own, oats were commonly dried in stooks. Oats are the favourite food of rooks, but have been largely replaced by more profitable crops during the 1970s. The rooks were forced to find alternative foods, one of these was ripening winter barley

Right: The advent of efficient herbicides has led indirectly to the decline of the grey partridge. The birds that suffered were not the vegetarian adults, but the insect-eating chicks. The weeds of cereal crops support a wide variety of insects, without which fewer chicks survive

It is well known that gross environmental changes in farming can do serious harm to bird life, and some examples of this have been especially newsworthy. Many people have heard about the demise of the peregrine and the sparrowhawk in the post-war decades, following the introduction of persistently toxic insecticides such as DDT. On the other hand, the fact that these two species have been recovering steadily since DDT went out of use is less well known. Again, land drainage continues to hit the headlines as a threat to conservation, having once led to the extinction in Britain of the avocet and ruff as breeding birds. But new wetlands (although not of the same type) have continually been created during the same period, in the form of gravel pits and reservoirs and this has brought a new breeding species to Britain–the little ringed plover–without the fanfare of news headlines

'Subtle' changes DDT poisoning and land drainage may certainly cause gross ecological changes in the farmland habitat. There are, however, a number of other changes which, while important to the farmer, appear relatively insignificant to the general public. While the total areas of farmland devoted to arable and grassland crops have hardly changed at all in the last 40 years, there have been radical changes in the kinds and varieties of crops grown and in various cultivation techniques. These have all had their effects on birds, and although they have not caused disasters such as extinction they have transformed the pattern or life for farmland birds.

Ploughing in autumn While autumn-sown wheat has been a familiar crop for many years, none of the barley crop used to be sown in the autumn. However, winter (ie autumn-sown) barley has now become a very popular crop with farmers. In addition to providing large yields, it ripens early so that it can be harvested in July, and this, together with its autumn sowing, has produced a dramatic change in the timing of several events in the farmer's–and the rook's–calendar.

Sowing generally involves a considerable amount of field preparation, including ploughing, harrowing and then drilling. All of these activities turn over the soil to varying extents, bringing to the surface plenty of invertebrates, especially earthworms, which rooks and other birds can then eat. When the main cereal sowing occurred in the spring, this cultivation provided rooks with a ready supply of invertebrates during the birds' breeding

season, a time when they are in special need of this kind of food. The trend towards autumn sowing has effectively postponed this flush of invertebrates to a time when they are less essential in the birds' diet (although worms are nevertheless a favoured autumn food when they can be obtained)

The ripening crop The full effect of this change on rooks, gulls or other bird species that commonly follow the plough is not yet known, but the earlier ripening of the crop may provide for rooks at a time when they might otherwise be short of food – at the height of summer. For rooks, summer is when food becomes harder to find, for the ground is dry, making it difficult to dig out the invertebrates, which themselves become less active. Further, there is little else to which the birds can turn, for it is too early for acorns, fruit and seeds, and other suitable plant material. Ripening winter barley, however, does provide readily available food during this period of need in June and July, and as a result it is prone to damage by rooks

Different rotations Quite apart from birds that follow the plough, it is common for many farmland birds to rely, for a part of the year at least, on soil-dwelling invertebrates. Starlings, rooks, jackdaws, lapwings and golden plover all take these animals from the surface of the soil or just below. They are all adapted primarily to exploit the resources of grassland. But the nature of grassland and other fields that provide birds with grubs and worms has changed since the 1940s

Part of the change, for example, lies in the demise of traditional crop rotation systems. Despite regular cultivation, fields subjected to a grass/arable rotation still hold fairly large invertebrate populations. The modern change to cereal monoculture or to rotations without

Above Autumn ploughing became widespread with the introduction of winter cereals but it is being superseded in some farms by directly drilling the seed into burned off stubble

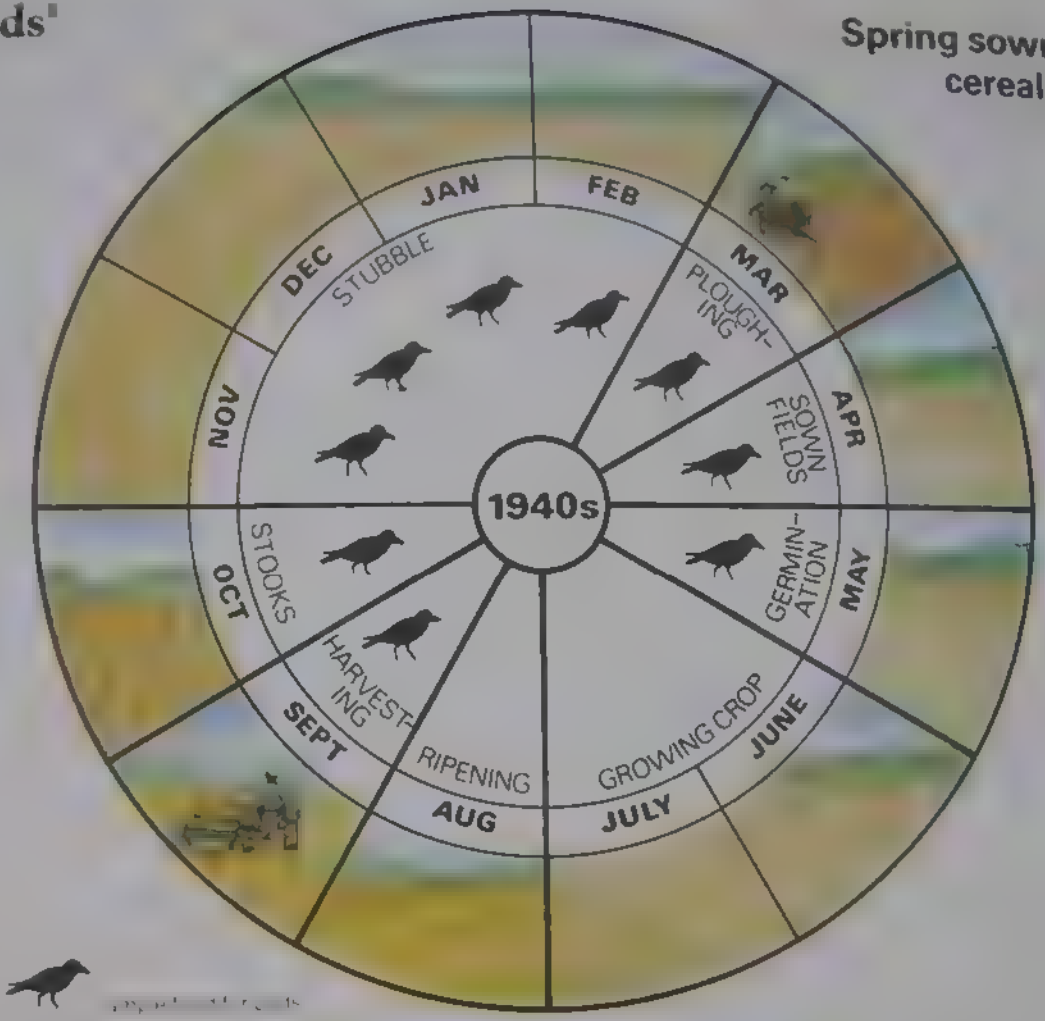
Below A good crop of oilseed rape, with a damaged crop shown in the lower picture This damage was done by the winter feeding of woodpigeons Before farmers provided these birds with rape, they had lived on clover in winter: but clover was phased out in the 1960s

grass (both made possible by the development of artificial fertilisers) has reduced both the number and diversity of these soil animals Thus the trend in farmland, especially in intensively cultivated areas, over the last 40 years, has been towards a reduction in the abundance of soil invertebrates, a reduction that may have contributed to the decline of the rook population in this period

Minimum ploughing Agricultural practices change continually and a development now taking place may, to a certain extent, reverse the trend towards impoverished invertebrate food sources within the soil. The burning of stubble provides a spectacular, if controversial, means of rapidly returning to the

The farmland birds' feeding calendar

Right: Traditional farming in Britain entailed a full nine months in which birds could find ample food. Farm birds include rooks, crows, jackdaws, starlings, sparrows, finches, buntings, wagtails and gulls. Spring sowing was the traditional method, and from the farmer's point of view the year began in March. This was when the land was cultivated prior to sowing. From the birds' point of view, the year might be said to begin in September, when harvesting left spilt grain in the stubble. Corn was bound into stooks and these stood in the fields to dry throughout October Standing stooks provided plentiful grain for rooks and other birds. Stubble feeding continued all through winter until spring cultivation. For a few weeks into May, the germinating seeds were an additional food source



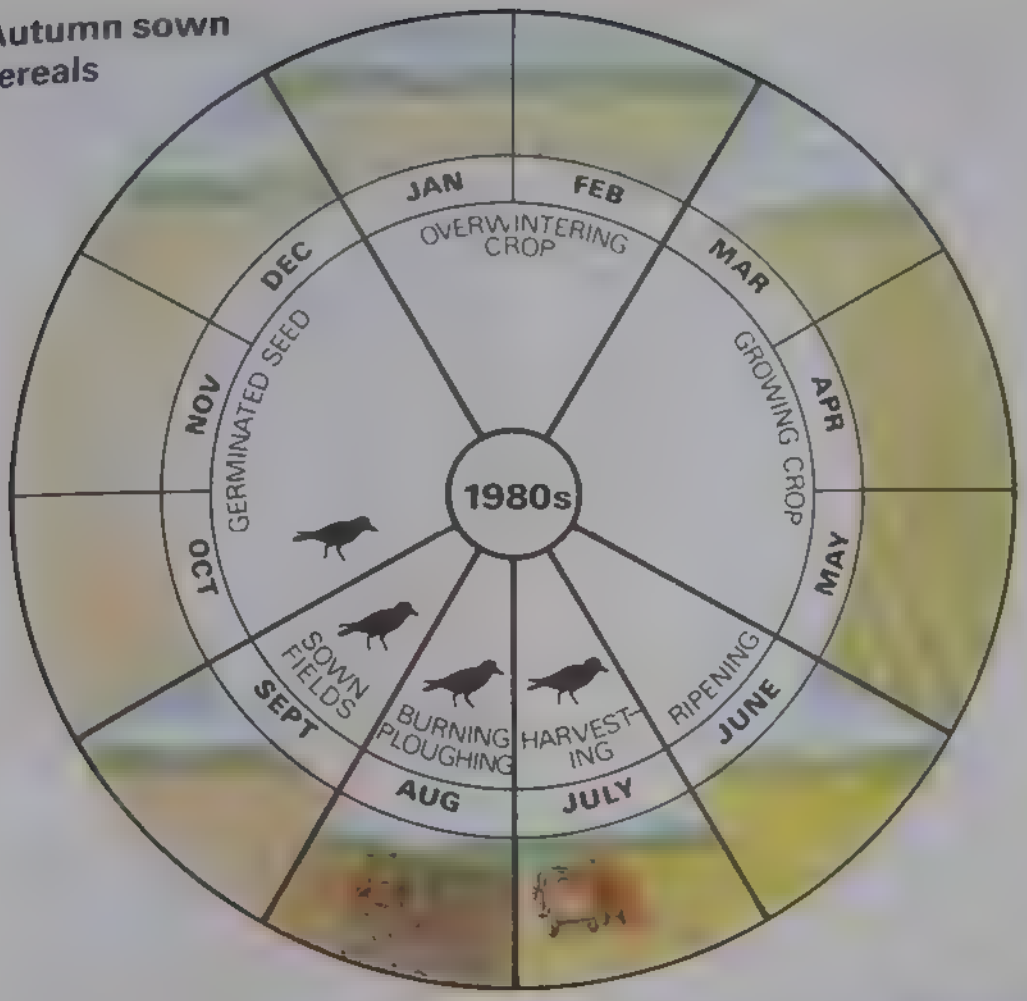
soil some nutrients from otherwise unwanted material. Stubble burning has now, however, become part of a system of intensive arable farming which aims to minimise soil disturbance. This is known as 'minimum cultivation'–a technique of farming whereby a new sowing can be drilled directly, or with little cultivation, into the burned-off stubble of a previous crop. With its reduced disturbance of the soil, minimum cultivation might well lead to a recovery of the soil invertebrate populations, to the benefit of many farmland birds.

Below: Stubble burning is the result of changes in the farm calendar and a fall in the value of straw. It can be followed by autumn ploughing and sowing, or by direct drilling of the seed

Don't scrap the plough However, while minimum cultivation may provide a long-term increase in the food supplies of our traditional grassland, the absence of autumn ploughing could deprive us of one of our more picturesque farming scenes–flocks of gulls following the plough. But the plough is making a comeback in a dual role: firstly to bury annual grass seeds, such as blackgrass and barren brome, and secondly to mix burnt plant material down from the surface of the soil where it can inhibit the effects of certain weedkillers.

Direct drilling Another effect of minimum cultivation on bird life was seen in the 1970s, when farmers began to report that starlings had begun to dig up sprouting cereals, especially those sown in autumn. This became a serious problem when vast flocks of birds assembled for the last feed of the day before entering a communal roost for the long winter night.

The reason underlying this spate of digging winter cereals seems to have been a tendency to sow the seed more shallowly than in previous decades. This arises from the modern practice of direct drilling, used to sow the seed into land that has received minimum or no



Left For the modern cereal farmer, the land is under cultivation all year round. In spring he is occupied with management of the growing crop, which he harvests in July In this illustration a sequence of burning and ploughing is used, but alternatively the seed can be sown by direct drilling. The germinated crop grows slowly during autumn, and overwinters in January and February. For the birds, the fields do not begin to be attractive until harvesting, which is in the summer Ploughing, sowing and germinating only occupy four months in comparison with the nine 'useful' months of the traditional calendar One major difference is that no ploughing takes place in spring; to the birds, this amounts to a loss of protein-rich soil animals, particularly earthworms, which the birds need to feed to their growing chicks in spring. This loss is partly offset by the plentiful supply of ripe grains in July

ploughing. The drills penetrate sufficiently deeply to allow most of the seed to be covered, but the depth of sowing is about 2.5cm (1in)–the depth to which a starling's bill can probe. Now, therefore, starlings can reach the grain and the recent spate of damage has resulted directly from the change in farming practice.

In intensively cultivated countries such as Britain and most other countries of Western Europe and North America, the effects of subtle changes in farming practices on the well-being of the birds is hard to predict. It is certain, however, that in this 'swings and roundabouts' situation, if some bird species suffer, others are bound to benefit, or indeed to thrive.

Right. Rook damage along the edge of a field of winter wheat. The rooks jump off the fence and knock down the standing wheat with their outstretched wings. They then eat the fallen ears.

Below: A skylark at its nest. In spring, skylarks graze the cotyledons of growing weeds. If the modern farmer uses weedkillers effectively, the birds are forced to turn to the crop Sugar beet is often damaged in this way

SEA-FIRS AND OTHER HYDROIDS

Among the purely aquatic groups of animals some, such as the starfishes for instance, are well known. Others, however, remain mostly unseen and little known. Among the latter are the hydroids–close relatives of the jellyfishes and anemones.

Right: Hydroids have few enemies, though sea spiders are often found crawling and apparently feeding on them Shown here is the hydroid *Nemertesia ramosa* with several sea spiders, *Endeis spinosa*, clambering over it, their long thin legs looking like strands of white cotton

Below: Colonies of *Tubularia indivisa* Several species of sea slug have become adapted to feeding on this and other hydroids despite the presence of stinging cells

Most hydroids are colonial animals, consisting of a number of individuals known as polyps connected by a hollow extension of the communal gut into an encrusting or upright branching colony In many species individual polyps are specialised either for feeding the colony or for reproduction. Each feeding polyp resembles a minute sea-anemone, with a ring of tentacles surrounding a mouth leading into a sac-like stomach which occupies the whole of the body cavity The tentacles are heavily armed with stinging cells and capture minute animals from the water These are transferred into the mouth and digested, and then the remains are ejected from the mouth There is no 'through' gut as there is in higher animals.

Although hydroids are not familiar animals to most people, they are common in the sea, and play an important part in marine ecology They are less common in tropical waters although some species are found on coral reefs and are often called fire coral because of their painful stings. In the British Isles they are present on most shores and may be abundant offshore, where they are encountered by divers.

Alternate generations Most hydroids, like jellyfishes, exhibit alternation of generations. This means that the life-cycle produces generations which alternate between reproducing sexually and reproducing asexually. In hydroids the asexually produced form is called the medusa. The medusa is produced by budding from the parent hydroid–no sexual reproduction or fertilisation is involved at this stage. The medusa, which swims off into the water and becomes part of the plankton, eats smaller planktonic animals, and resembles a small jellyfish. Once it has grown to a certain size, usually about 1cm (½in), it becomes sexually mature, releasing eggs and sperm into the water. (This is the sexually reproducing part of the life-cycle.) Some of the eggs are fertilised and develop into tiny larvae which sink or swim to the sea-bed, search for a suitable habitat and begin to grow into a hydroid colony.

Two groups The hydroids are divided into two major groups, the Athecata and the Thecata, on the basis of whether or not the polyp is surrounded by a theca or protective cup The Athecata are generally thought to be more primitive, their polyps are not protected by a theca into which they can withdraw, and they do not have a clear separation of their polyps into feeding and reproductive types

Athecate hydroids *Tubularia indivisa* and *Tubularia larynx* are two common athecate hydroids which live in places with much water movement - either strong tidal streams or powerful ocean swells. They persist throughout the year as masses of twisted stems, at the ends of which polyps appear in early spring when food becomes abundant. Then *Tubularia* grows rapidly and reproduces quickly so that it can colonize new habitats such as the bottom of a boat, which it can cover entirely in weeks

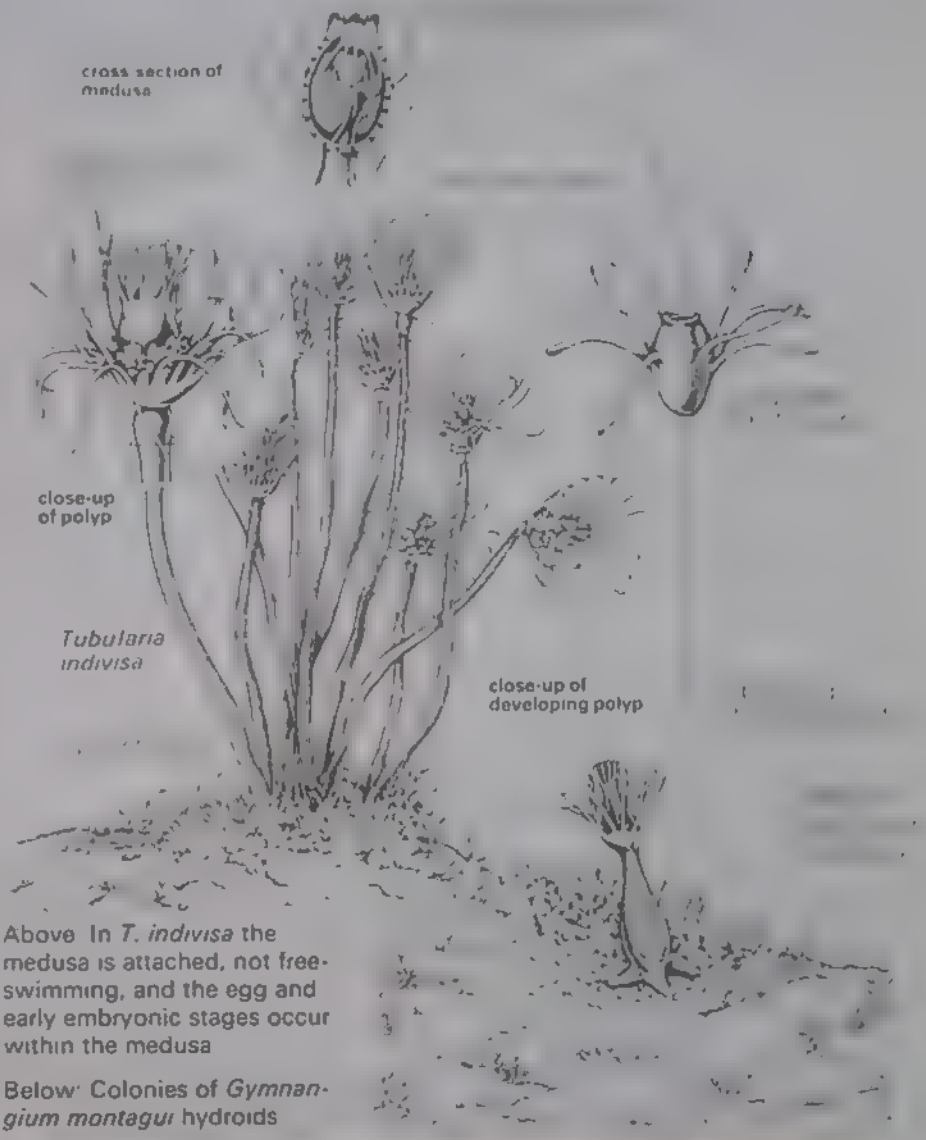
Thecate hydroids These tend to form larger, more elaborate colonies, with smaller polyps than most athecates. The body of each polyp is enclosed in a theca, made of a protein material similar to the external skeleton of insects The polyp can withdraw into this cup, complete with its tentacles, and some even have flaps or lids to close the entrance, presumably to deter predators. The reproductive polyps are usually quite separate from the feeding polyps of the colony, and may produce either medusae or planula larvae directly, omitting the medusa part of the life-cycle

Sertularia argentea is a typical member of the thecate family Sertulariidae. The colony is elaborately branched in three dimensions like a Christmas tree, hence the common name sea-fir. A typical colony is about 20cm (8in) in length, with thousands of polyps on its branches, like the leaves of a tree. Another species of the same family, *Abietinaria abietina*, forms a flattened, fan-like colony which usually grows at right angles to the current, so that the polyps act like the meshes of a net to catch plankton

Advanced hydroids The Plumulariidae are probably the most elaborate of the thecate hydroids. As well as having polyps for feeding and reproduction, these hydroids have special small polyps with powerful stinging cells which are thought to be for the defence of the colony. Most colonies of the Plumulariidae are flattened in shape, with strong central stems and fine lateral branches, resembling a feather. *Gymnangium montagui* is a typical example; it lives in rocky, exposed places on the western coasts of the British Isles, usually at depths of 20-30m (10-15 fathoms). *Nemertesia antennina* is a plumulariid hydroid which, rather than being feather-like, has branches sticking out all round the stem. It grows very fast, producing three generations a year.

The larvae of a plumulariid hydroid are very selective when they come to settle on the sea-bed, and prefer to grow on the base of an old colony rather than on a fresh site. After a few generations, therefore, large clumps of the hydroid build up. When you see one of these clumps it is hard to believe that each of the upright colonies that make up the clump is in fact a separate individual, having grown from a separate larva. The cluster of colonies may have been present for many years.

Life-cycle of a hydroid



Above In *T. indivisa* the medusa is attached, not free-swimming, and the egg and early embryonic stages occur within the medusa

Below Colonies of *Gymnangium montagui* hydroids

SUTHERLAND: WHERE MOUNTAIN MEETS SEA

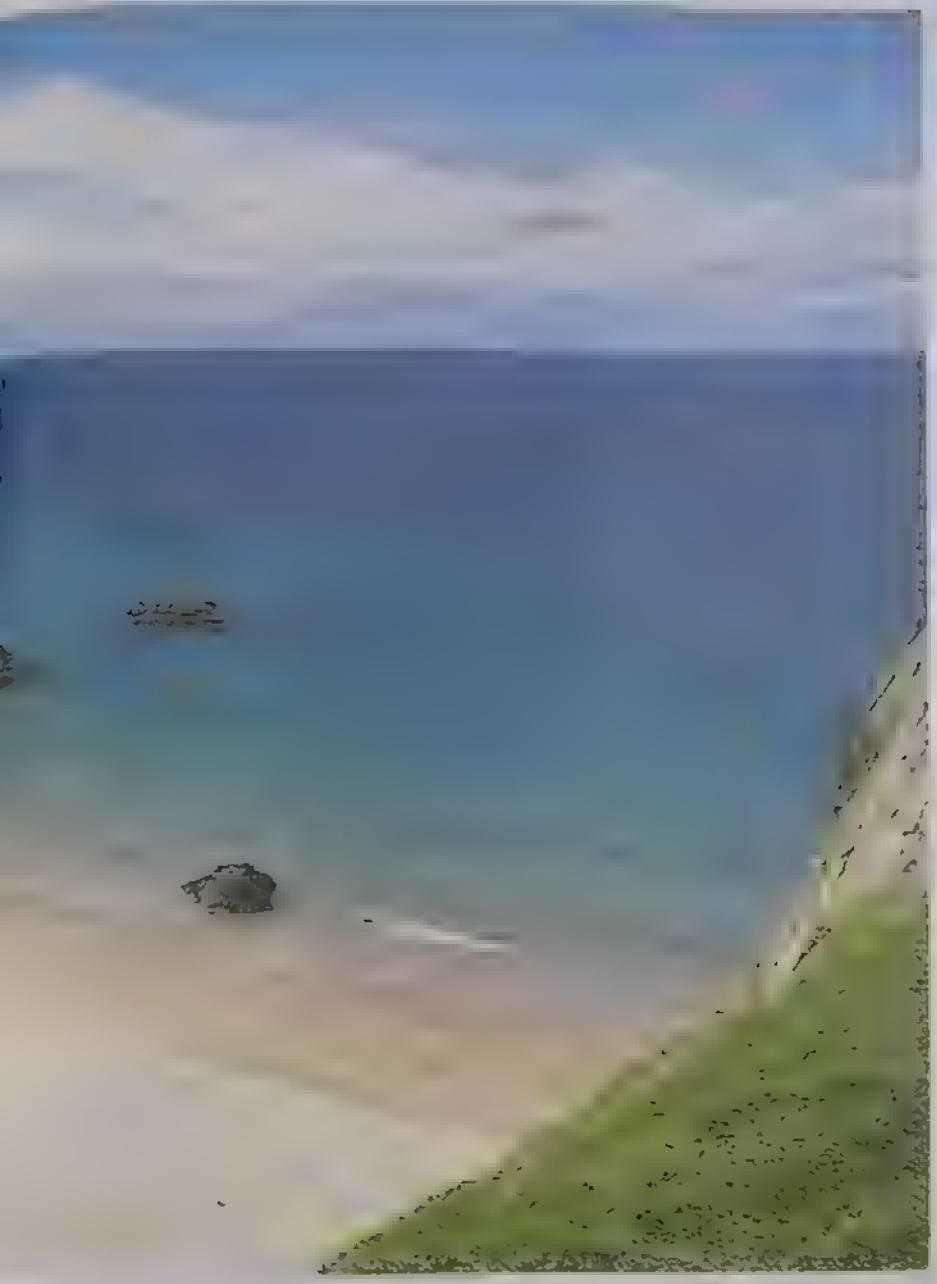
In most parts of Britain you have to climb several thousand feet to find alpine plants, but in Sutherland in the far north of Scotland these alpines occur at much lower altitudes. In some cases they grow right down at sea level where they can be found along the north coast mixing with maritime plants.

Sutherland lies at the very far north of mainland Scotland–due north there is nothing but open sea until you reach the ice pack of the Arctic Circle. It lies beyond the great mountains of the Highlands and contains only a few hills of any great height. Away from the coast, indeed, the main feature of Sutherland is the great central plain known as A'Mhoine, a barren land of heather and boglands built up over the very ancient rocks of the Moine thrust.

The coastline, by contrast, is spectacularly wild and rugged. It experiences some of the worst weather anywhere in Britain–a fact clearly demonstrated by the low set and massive walls of the houses along the coast. At Clo Mor near Cape Wrath, the most north-westerly point of mainland Britain, the cliffs

Above: Sango Bay, along the north coast of Sutherland The village of Durness lies just outside the picture to the left, and in the distance is the promontory known as Faraid Head. The parish of Durness has the distinction of being Scotland's most sparsely populated parish, with just 2.4 people per square mile

Opposite right: Mountain milk-vetch (*Oxytropis halleri*) usually occurs as an alpine species in Britain; in Perthshire, Tayside, for example it grows at altitudes above 600m (2000ft). Yet in Sutherland it grows more or less at sea level on sand dunes. A member of the pea family, this plant can be distinguished by its silky, pinnately arranged leaves.



rise to a height of 270m (900ft)

Land without trees The vegetation is very much in keeping with the wildness of the scenery. Woodlands are rare in Sutherland, due as much as anything to the depredations of man though an important factor is that the tree line is more or less at sea level throughout the north of the county. The tree line is the height above sea level above which trees are unable to grow. It may be as high as 4000m (13,000ft) in tropical and sub-tropical regions and it decreases towards the Poles. In central and southern Scotland the tree line is at least 300m (1000ft) above sea level and occasionally higher. But because it is virtually at sea level in the north of Sutherland the coastline of the area is rich in plants normally found only on mountains–the arctic and alpine species.

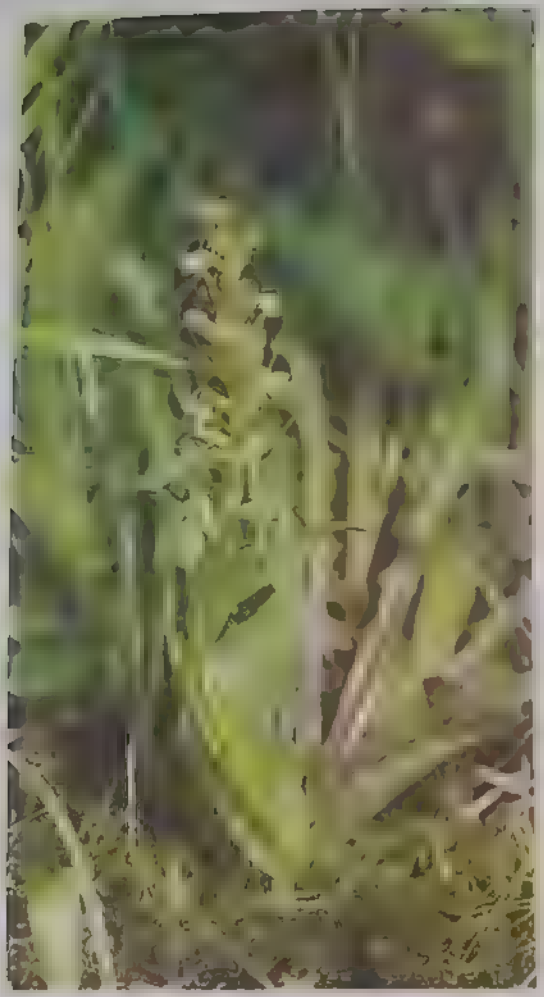
Dryas heath A good example of this can be seen in mountain avens (*Dryas octopetala*). This is a creeping shrub with a mat of small evergreen leaves. From this mat arise single flower stalks, each bearing a white, usually eight-petalled flower about 2.5cm (1in) across.

Mountain avens is a rare plant usually found on mountains in small numbers, but occasionally it is present in sufficient quantity to be the dominant species. The result is called a *Dryas* heath. Such a heathland always occurs on alkaline soils and is always very rich in species: up to 215 different species have been recorded from one site. In the Scottish Highlands *Dryas* heath occurs sporadically at Glen Coe and in Lakeside for example, where it is found at about 1000m (3300ft). In Sutherland it occurs along a belt of limestone from Ben More Assynt in the south west of the county where it is at 500m (1700ft), up to Durness on the north coast where it is, at most, 15m (50ft) above sea level.

Further east along the coast from Durness there is a stretch of sand formed from highly calcareous shells, and here *Dryas* forms heaths over the sand dunes at sea level. This kind of heath is typical of the Arctic tundra.

Sand dune species The sand dunes of the north coast contain several other unexpected species; black bearberry for example, which usually occurs at altitudes of 1000m (3300ft) or more. Alpine meadow-rue and alpine lady's mantle are both common here, as are three saxifrages: the starry, mossy and purple. All three are normally plants of hills and mountains.

On the shell sands of Invernaver, which is at the east end of Sutherland's north coast, the purple-flowered mountain milk-vetch can be found. This member of the pea family can be distinguished by its very silky pinnate leaves and its heads of rose-purple flowers. Growing very close by, however, are two maritime plants, sand sedge and marram grass, though among all these unusual alpine plants such typical sand dune plants look somewhat out of place.



Above: A field gentian (*Gentianella campestris*) growing on the grassy top of Faraid Head, overlooking Balnakiel Bay

Left. The frog orchid (*Coeloglossum viride*), with its shiny green leaves and flowers with reddish-brown lips, is found all along the Sutherland coast

Below Grass of Parnassus (*Parnassia palustris*), a plant of wet marshy ground, is not a member of the grass family despite its name

Durness limestone Returning west along the north coast to Durness, the band of limestone that stretches down to Ben More Assynt begins at a cave just east of Durness. The cave is called Smoo Cave and it is simply a very large hole in the cliff along the coast, formed by a small stream flowing through the limestone rock and out into the sea.

On these limestone cliffs can be found such alpine plants as rose root, a member of the stonecrop family and a typical species at altitudes of 600m (2000ft) or more. Moss campion can be found growing here, looking quite out of place alongside its relative, sea campion. The former is a low-growing, cushion-forming plant with pink flowers usually found on mountain cliffs and screes, while the latter is rather taller with white flowers and is a true maritime species. Also growing on the rock ledge of the Durness limestone outcrop is mountain sorrel, an unmistakable plant that usually indicates a reasonably high altitude. Its flowers and fruits are typical for a member of the dock family but it has unusual fleshy leaves.

Faraid Head On the west side of Durness–the other side of the village from Smoo Cave–is the small settlement of Balnakiel, and running north from this is a long promontory called Faraid Head. At the base of the headland, looking west over Balnakiel Bay, is a cliff consisting of Durness limestone. This area of cliff is particularly interesting because some of the plants found there are associated with several conflicting habitats

Sea plantain definitely establishes the cliff as being by the sea (not surprisingly!) yet, like other parts of the coast, the area also seems to be montane–as indicated by the presence of mountain cat's-foot, which is a member of the daisy family, and viviparous bistort, a member of the dock family. The area is definitely damp, because there are occasional patches of field gentian and grass of Parnassus, and the occurrence of crowberry indicates an area both wet and montane

Some of the plants on the cliff, however, seem to indicate that the area is just ordinary limestone turf: fairy flax, for example, a plant

A guide to Sutherland

Above: Sutherland (administratively now part of Highland Region) lies at the far north-western end of mainland Scotland. Much of the area is flat and dominated by heather and bogland though there are some substantial hills, including Ben More Assynt (998m/3273ft) in the south-west of the county and Ben Hope (927m/3042ft) in the north

Below: The Scots primrose (*Primula scotica*) is found only along the north coast of Scotland and the Orkney Islands–and nowhere else in the world. This plant was once thought to be native to Norway as well, but the Norwegian plants have since turned out to be a closely related but distinct species called *Primula scandinabrica*. The Scots primrose flowers between June and September

that only occurs in alkaline conditions such as those found on limestone turf. This impression is reinforced by the presence of kidney vetch, which is more at home on the chalk downs of southern England, and wild thyme, which is another typical plant of southern chalk land. Common milkwort, small hawkweed and bird's-foot trefoil are all grassland species found on this cliff. Also present are two species of orchid–a very small specimen of common twayblade which is another plant that favours calcareous soils, and frog orchid. The latter is common all along the coast

Scots primrose On the cliff-top of Faraid Head can be found one very special plant that is restricted solely to the north coast of Scotland and a few of the islands–it is found nowhere else in the world. This plant is the Scots primrose. Varying in height from just 2cm (¾in) up to 8cm (3in), Scots primrose has a rosette of small, usually untoothed leaves which are broadest in the middle and covered on their undersides with a mealy coating. The flower stalk is also mealy and bears between one and four flowers. These are about 1cm (½in) across and purple with a bright yellow 'eye' in the centre. This superb little plant is found in damp areas all the way along the north coast of Sutherland and also of Caithness. It occurs in Orkney as well, and that is the sum of its range.

The particular climatic conditions that can turn so many alpine plants into seaside vegetation will always have a fascination for the naturalist, the more so because conditions in some parts of the area are noticeably harsher than in others. This is reflected in the fact that the tree line, which is at sea level along much of the coast, rises to 300m (1000ft) on Ben Loyal. Such whims of climate serve to make plant-hunting more interesting–and occasionally more confusing.

EVERGREEN PITTOSPORUMS

Parts of southern England and Ireland are just mild enough to allow a group of evergreen trees from 'Down Under' to survive–and in a few places even to become naturalised. These are the pittosporums, with their ornamental foliage and fragrant flowers.

Pittosporums belong to a genus of some 150 species of tropical and sub-tropical trees and shrubs found in Australasia and south-east Asia. The name 'pittosporum' refers to the black resinous coating of the seeds, so favoured by birds ('pitta' meaning pitch and 'sporus' meaning seed). Most of the species growing in the British Isles have been introduced here from Australia or New Zealand.

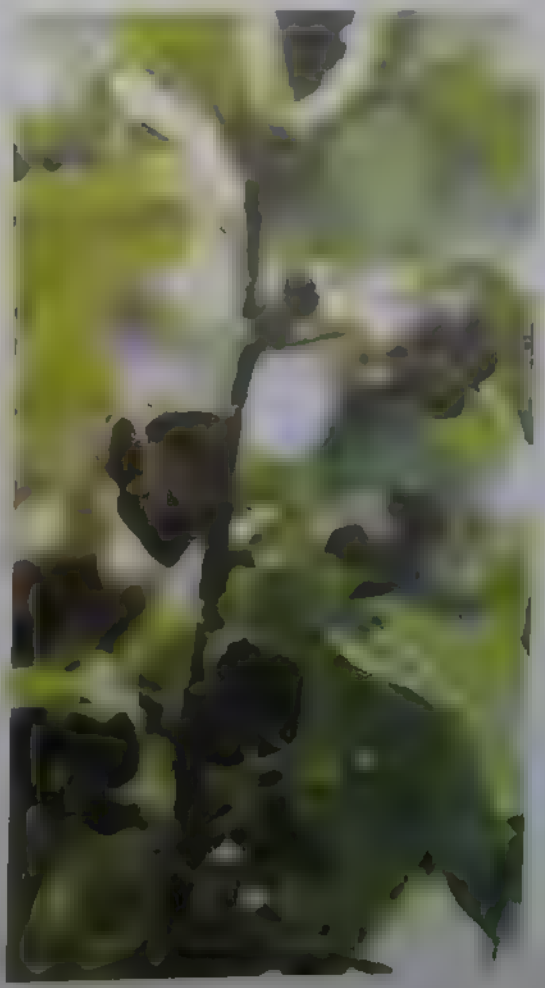
All pittosporums have their leaves borne alternately but these are often clustered into 'pseudo-whorls' around the stem. The leaves are usually leathery with smooth margins. The flowers are often aromatic but are not very distinctive to look at: typically they are about 1cm (½in) in diameter with five petals joined at the base and spreading out to form a small cup. The fruit capsules are rounded, woody when mature, and contain resinous seeds.

The plants were first collected in Australia and New Zealand in 1770 by Sir Joseph Banks and Dr Daniel Solander on Captain Cook's first voyage to that part of the world. Today about a dozen species are regularly cultivated.

Kohuhu from New Zealand One of the commonest species seen in the British Isles is *Pittosporum tenuifolium*, which is found mainly in the sheltered southern and south-western counties where it grows in hedgerows protected from the wind. In its native New Zealand it is commonly called tawhiwhi or kohuhu

P. tenuifolium grows to a height of 10m (33ft) and is easily recognised by its wavy silvery-green foliage supported by an abundance of thin, usually black stems. The flowers are reddish-purple and borne singly in the axils where the leaves meet the stem. Their main attraction is their heavy honey-sweet fragrance, which is at its best in the evening. Good specimens of this plant are common in south-west England, though it does occur in other sheltered parts of the country, including the east and south

Numerous varieties of *P. tenuifolium* have been developed, and they are especially popular with florists, not only for their attractive leaf patterns but also because their



Above: One of the species from the Far East seen in Britain is *Pittosporum tobira*. The creamy-white flowers measure about 1cm (½in) in diameter and are borne in clusters at the ends of the shoots. They have a delightful fragrance reminiscent of orange blossom, which is why the plant is known as mock orange

Right: The purple flowers of *P. tenuifolium*, one of the commonest and hardiest growing in Britain.

cut stems last a long time

Two similar species New Zealand is also the home of *P. crassifolium*, commonly known as karo, and *P. ralphii*–two species that are very similar to each other. Both are shrubs or small trees growing to a height of about 5m (16ft), and they both have particularly dense growth habits (for which reason they are widely planted in the Scilly Isles as sheltering fences for bulb fields). The leaves are covered in a whitish or brown felt when young. Karo has dark purple flowers whereas *P. ralphii* has crimson flowers borne on shorter stalks. The two species frequently hybridise with each other, which adds to the difficulty of identifying them. Neither of them flowers very freely in the British Isles, though they make interesting evergreens in the warmer counties

Mock orange Native to China, Taiwan, Korea and Japan, *P. tobira* was introduced to Kew Gardens in 1804. In this country it is better known as mock orange because its flowers have a delightful fragrance of orange blossom

Mock orange is a bushy shrub that can grow to be over 6m (20ft) high. The leaves are lance-shaped and can vary in length from between 2cm (¾in) and 15cm (6in). The creamy-white flowers are borne in clusters at the ends of the shoots. This species grows best in the south-western counties of England and Ireland. An attractive slow-growing cultivar of mock orange has been developed. Called 'Variegatum', it has greyish-green leaves variegated with white (ie, with white patches).

Native daphne One of the worst weed trees in Australia is a species of *Pittosporum* called native daphne (*P. undulatum*). The main reason why it has become such a nuisance in Australia is that its seeds are being spread by blackbirds introduced there from Europe

In the British Isles however native daphne forms a handsome ornamental tree sometimes growing to a height of 12m (40ft). Its laurel-like leaves have characteristically undulating margins and its creamy-white flowers are scattered throughout the foliage in terminal clusters: at night they can fill a whole garden with their scent. The showy orange-coloured fruits make this tree very attractive in the winter

Native daphne was introduced to Britain from its native eastern Australia in 1789. It can survive only in mild counties over here, and good examples can be seen in Ireland and the West Country

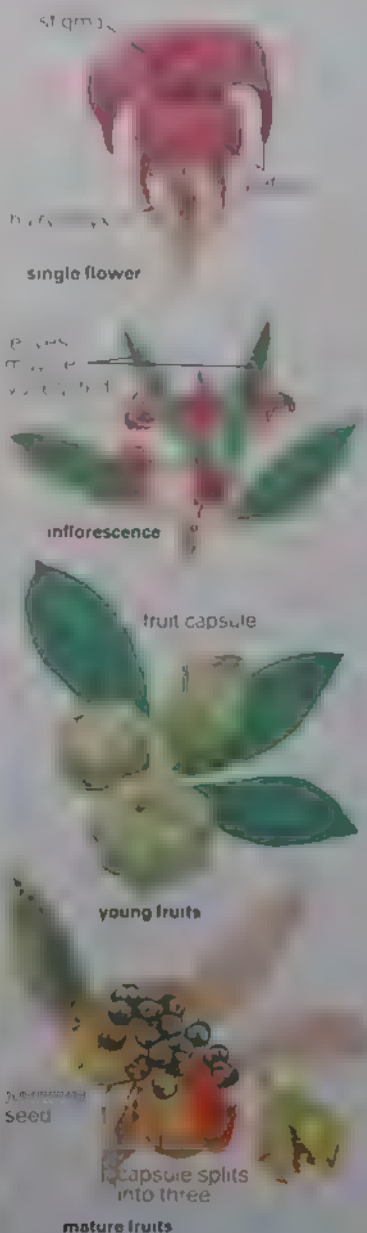
The tarata and others The tarata (*P. eugenioides*) is a delightful, densely branched shrub up to 12m (40ft) high. The leaves are dark glossy green and clustered at the ends of the current season's growth. The flowers are yellowish and packed into loose inflorescences. They have a honey-like scent, and the leaves–when crushed–are also fragrant. There is a variegated form with creamy-white margins to the leaves. Its tall clean columnar shape is a distinctive sight in Cornish gardens

Among the less common species of *Pittosporum* in Britain, *P. patulum* is one of the hardiest members of the genus in this country. Its dark red flowers are considered to be the most fragrant of all New Zealand's pittosporums. It is a small tree, growing to about 5m (16ft) high, with lance-shaped toothed leaves

Another small tree with dark red flowers is *P. bicolor* from Tasmania. In sheltered conditions it can reach a height of 10m (33ft). *P. dalli* is one of the most handsome species with coarsely toothed leaves and sweet-smelling white flowers

Above: A mature specimen of native daphne (*P. undulatum*) can grow to a height of 12m (40ft)

Below: Flowers and fruits of *P. crassifolium* from New Zealand



Left. The tarata (*P. eugenioides*) bears loose clusters of fragrant yellow flowers.

RIVER SHINGLE BEDS

Shingle is a term normally associated with the coast, yet extensive shingle beds are found in and adjacent to Britain's rivers. They are generally transient and must rank as among our most unstable inland habitats.

Opposite page Nootka lupins (*Lupinus nootkatensis*) flourishing on extensive shingle banks in the River Dee near Braemar in Scotland. These blue and white flowers are relatives of our common garden cultivated varieties

Below Balsam (*Impatiens*) has strong, tenacious roots that enable it to grip firmly on to unstable shingle even when the river is in flood

In all river systems the presence of shingle is associated with the river's inability to weather its bedrock into fine sands or silt. (Shingle formation results from the ability of a river to erode, transport and then sediment materials.) Thus shingle banks (or bars) in rivers are prevalent in parts of Britain where the bedrock is hard–in Scotland, northern England, Wales and south-west England. In general, shingle bars in the upper reaches of these rivers are haphazardly deposited and composed of small boulders and pebbles, yet in their lower reaches the shingle bars are more stable and composed of much finer gravels. The slope of the river as it races down from the hills and on to the flood plains thus shifts through the easily eroded particles, carrying the lighter, and finer, particles further downstream

Although shingle bars are characteristic of those rivers which rise in mountains, distinctive examples also occur in the lowlands of Britain. Lowland river shingles are associated with younger rocks which offer some resistance to weathering: the Tertiary Sands found in the New Forest, the Greensands of the Weald, the crags of East Anglia, the older and harder sandstones of Devon and South Wales, and the Oolite of the Cotswolds and Northamptonshire Uplands. Even lowland rivers in catchments without hard rocks may also have shingle bars if they flow through coarse drift deposits. These inherently unstable deposits were brought into the area thousands of years ago by retreating glaciers or previous large rivers. Good examples of river shingles derived from glacial gravels are found in the Swale, Ure and Wharfe rivers as they flow into lowland Yorkshire. On the other hand, river gravels are a very common feature of many rivers, and the Wye, Severn and Avon are particularly good examples.

Formation of shingle beds In all cases, the dynamic nature of rivers means that, in some parts of a system, erosion exceeds deposition, whereas in others deposition exceeds erosion. Since these areas may change, the shingle beds which are created are intrinsically unstable

and short-lived habitats. The processes which lead to their formation thus ultimately lead to their destruction

In mountainous and upland regions in Britain the shingle beds of rivers are generally composed of large cobbles and pebbles. If no coarse sands and gravels are available, these shingle beds will support no plant species at all because the beds are destroyed and created many times over in a single year as the cobbles roll over one another every time the river rises and falls. The introduction of finer particles provides a firmer base into which the cobbles can become embedded and these shingles can survive all but the largest floods. Eventually, however, they fall victim to the river's immense erosive flood power. As the river subsides to a tranquil trickle it now runs alongside the virgin shingle beds which it created only days before.

As rivers race seawards from their upland sources, they are often contained in their channels by steep-sided valleys, which preclude significant shingle formation. Additional confinement may be provided by tree-lined banks which resist erosion. If, however, a river flows into a U-shaped valley (characteristically created by glaciation), the flat bottom provides ample opportunity for the river to meander and change course. The valley floor therefore does not restrict the river to a discrete channel and shingle banks abound. These river shingles are characteristic of many rivers in Scotland and the Dales rivers of the Pennines.

Flood plain river shingles are a common feature of many fast-flowing rivers as they traverse large expanses of flat land. The rivers, released from the straight-jacket of their youthful confinement to narrow channels, become wayward in behaviour–amply illustrated by such rivers as the Afon Rheidol and Ystwyth in West Wales. Both rise high on the Cambrian Mountains and make hurried journeys to Cardigan Bay near Aberystwyth In the flood plain both these small rivers flow in channels up to 400m (1300ft) wide, with the water actually occupying less than 5% of the area; the rest is river shingle

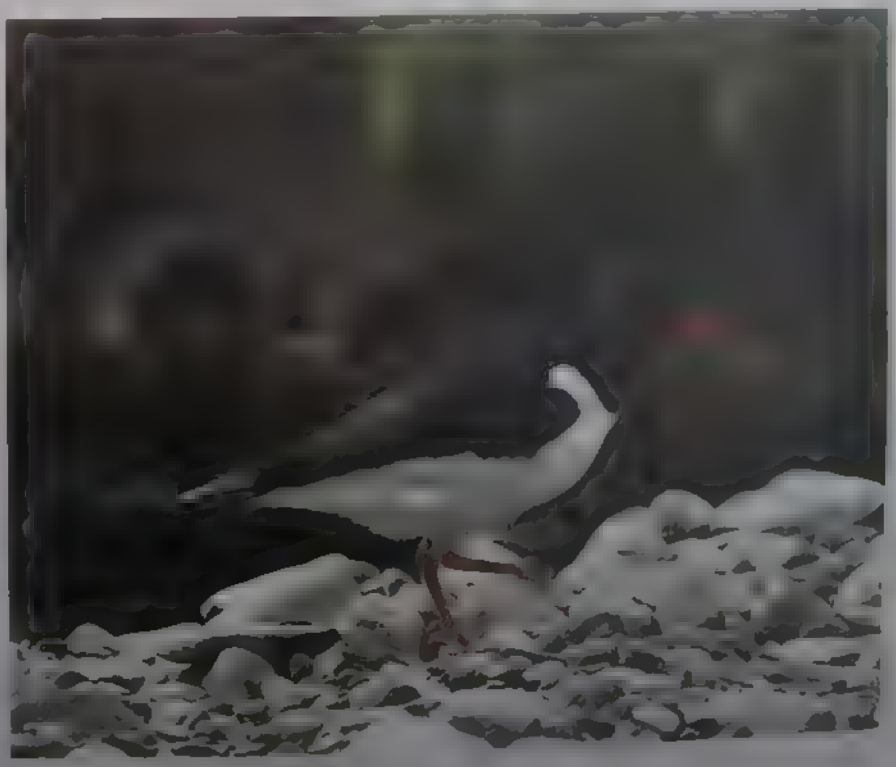
Most shingles in fast-flowing upland rivers have been derived from a downstream transport of shingle which is all the time being moved both laterally and downstream. Rivers with their catchments entirely in the lowlands frequently do not illustrate large downstream movements of shingle; instead, they frequently erode into banks or throw bed material into small shoals. Shingle beds in lowland rivers are very closely correlated with two features, a meandering channel in which the deflection of currents facilitates natural erosion and deposition zones, and an abundance of gravel derived either from eroded bedrock or from Quarternary deposits. An easy guide to finding lowland rivers with shingle bars is to find out if gravel extraction pits are found within a catchment

A vivid demonstration of the effect of geology on the ability of a lowland river to form shingle bars is seen in the River Waveney in East Anglia. It rises at less than 30m (100ft) above sea level on clay and flows entirely over this for more than half its fresh-water length until it reaches coarse crags near Hoxne Above this point gravel beds do not occur in the river, yet below it the river erodes into a flood plain containing gravel and pebbles and shingle banks abound

Upland shingle The main colonizers of upland shingle are fast-growing, prostrate plants which can exploit bare ground quickly as well as withstand desiccation during low

Above. Coltsfoot in flower on pebbly shingle

Below In the last few decades the oystercatcher has made river shingle bars a major nesting habitat–a change which is the key to its recent population increase The nest normally consists simply of a hollow lined with a few small pebbles or shells. Insects and worms on the shingle are just as good a source of food as the oystercatcher's usual diet of molluscs

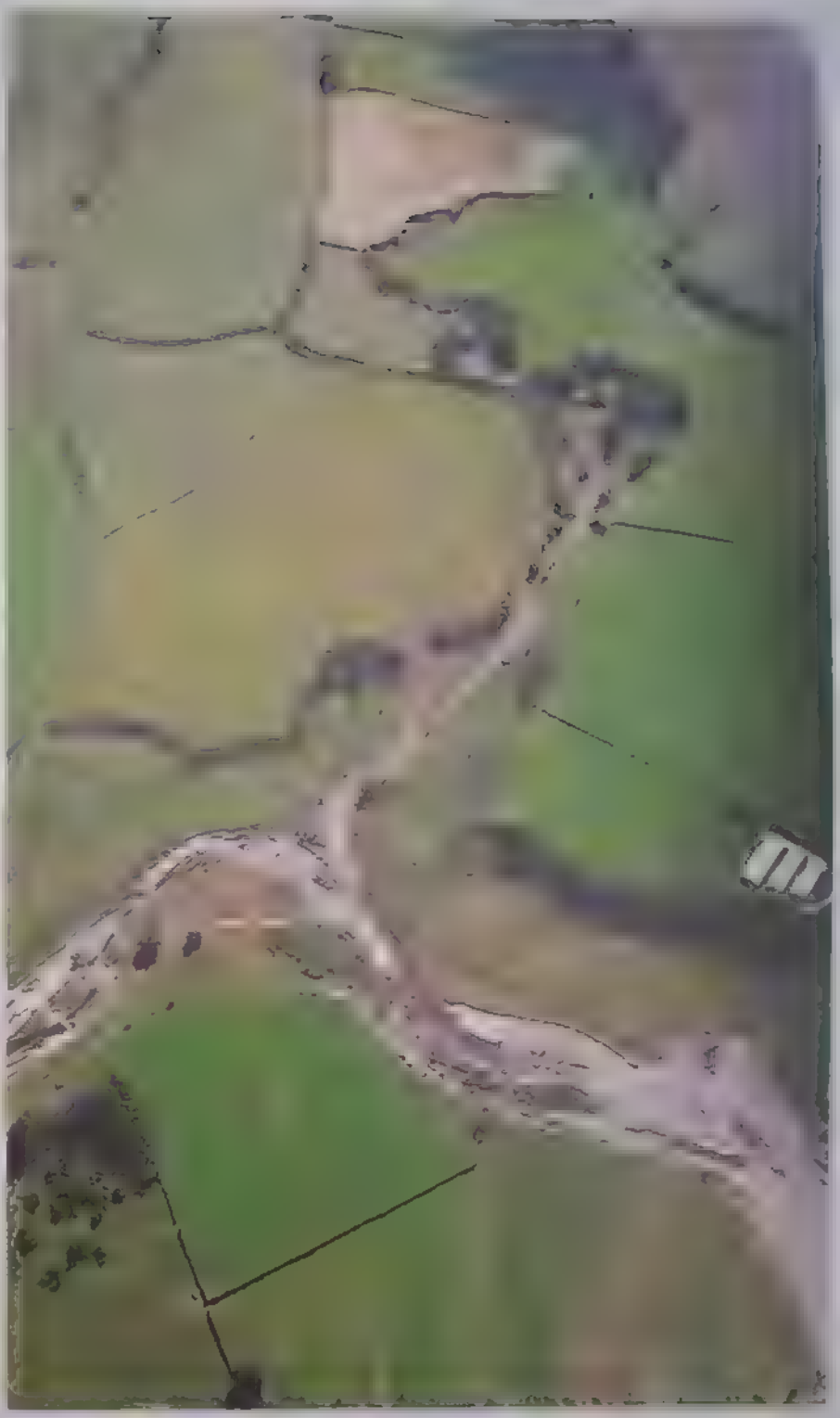


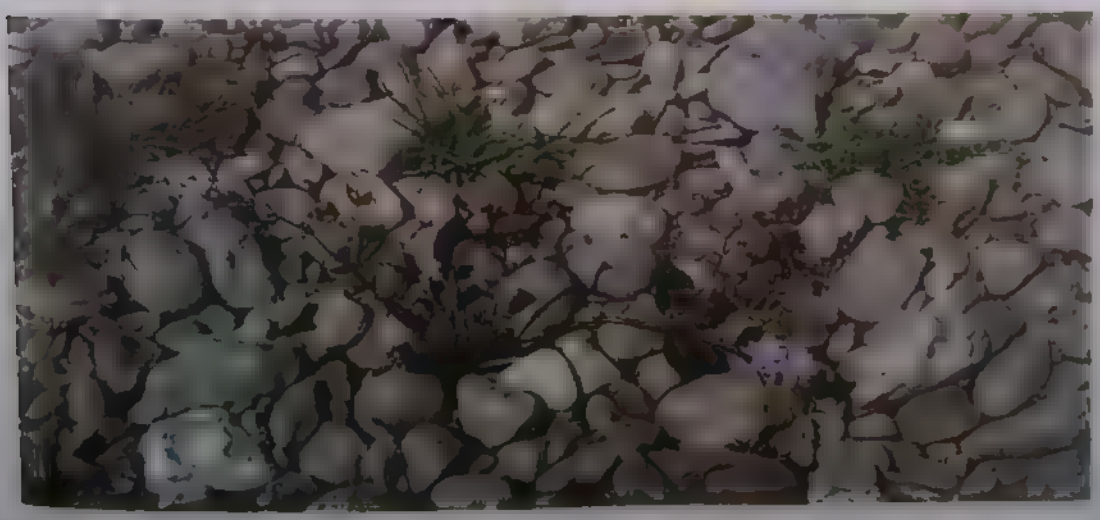
flow and erosion during floods. Although shingle composed of only cobbles and pebbles cannot sustain any plants at all, a number of shingle beds with superficial resemblance to them can support sparse vegetation. Below the surface cobbles of these beds there are fine gravels and coarse sands which provide just sufficient moisture and stability to allow such plants as pink purslane, alpine willowherb and procumbent sandwort to root. Once these establish themselves and add stability to the shingle by trapping detritus, a whole new range of plants can invade

Prime colonizers of stabilising upland gravels are mosses. Particularly common are such species as *Brachythecium*, *Philonotis*, *Calliergon*, *Bryum* and *Hyocomium*. Despite lacking flowers, these mosses can produce most attractive splashes of colour, the pale yellow-greens of *Philonotis fontana* contrasting with the venous red of *Bryum alpinum*. As the mosses themselves create better water-retention and stability within the shingle, such plants as jointed rush, common sedge, brown sedge, shepherd's cress and eyebright become established. Particular areas of the country have their specialities, with shrubby cinquefoil being a glacial relic left growing only on the coarse shingles of the River Tees near High Force and near Helvellyn in the Lake District. It is a tenaciously rooted shrub which can withstand the full force of torrential water as well as abrasion by the stones carried by the river

In the middle or lower reaches of upland rivers an immense variety of shingle bed communities can develop. Annuals are the prime colonizers, yet perennials which can hasten their reproductive processes also thrive. Creeping yellow-cress provides a late profusion of yellow flowers where earlier coltsfoot had also flowered. Both thrive because they root very deeply and gain moisture from sands below the shingle.

Among the specialised plants of gravel are to be found many opportunistic species, such as plantains, docks, trefoils, horsetails, bindweeds, knotweeds and many grasses. Yet despite this, different regions or even individual rivers have characteristic plants. In





Above: Extensive shingle beds have been deposited at the confluence of two rivers–the River Severn and the River Dulas. The shingle is partly vegetated–clearly stable enough not to be washed away by every flood. The more vegetation to become established, the firmer the shingle will be.

Left: Pink purslane is one species to look for on river shingle banks. Its pink flowers appear from April to July.

Above The moss *Bryum alpinum*, with its fruiting capsules. Such mosses are prime colonizers of upland gravels which are in the process of stabilising through the growth of firmly rooting flowering plants. As they grow, the mosses create greater stability and improve the water-retaining capacity of the shingle

Below Not many birds frequent shingle bars, but one you may well see is the colourful grey wagtail. It searches among the loose cobbles and gravels for a range of invertebrates

Bottom A view of the River Mor, in the Cairngorms. Here boulders and shingle have been brought down by snow melt water

Scotland the bellflower is a common colonizer of shingle, as are various forms of the pansy *Viola tricolor*. In rivers in northern England the most stable gravels may be colonized by [illegible] the gravels of the River Wye, on the other hand, are famed for being the home of wild chives.

In spite of such shingle being only sparsely vegetated, a few birds are often seen feeding upon them. Perhaps the most common is the grey wagtail, which bobs from stone to stone disturbing insects as it goes. The dipper is by no means confined to feeding in the middle of a rapid stream and frequently it, too, will search for worms and insects among damp shingle.

Lowland shingle The finer particles of the shingle beds deposited by lowland rivers result in greater moisture-retention and a higher nutrient status. The main colonizers are again opportunistic 'weed' species, some of which characteristically also exploit bare ground under cultivation. However, the inhabitants of river shingles must be able to withstand unstable and water-logged soil, as well as flood erosion. Early colonizers are all annuals – marsh yellow-cress, celery-leaved buttercup, knotgrass, red-shank, mallow, toad rush and such grasses as annual meadow grass are typical examples. Some amphibious species, such as the amphibious bistort and great yellow-cress, tend to utilise gravel banks as a step from dry land in their invasion into the water.

Few birds are specialist exploiters of lowland river shingles because they are insufficiently large to provide safe nesting sites during the summer. However, the little ringed plover has, in recent decades, established itself in Britain and utilised areas of loose gravel as nesting sites.

HOW FUNGI SCATTER SPORES

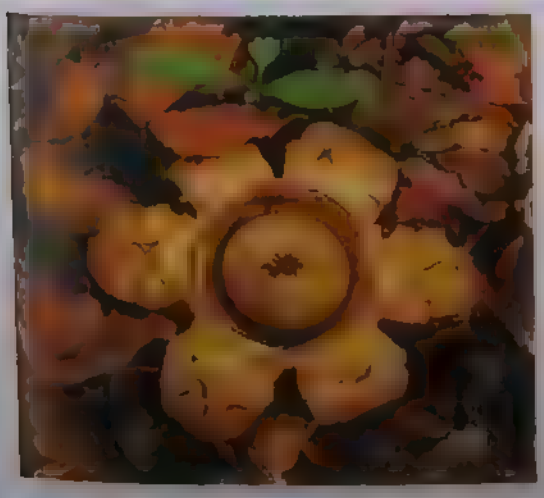
The weird and wonderful shapes of fungi, though a source of delight to us, simply reflect the different methods by which fungi disperse their spores

On any autumn walk in a wood or park you will see a wealth of fungal fruit bodies, such as mushrooms and bracket fungi, that appear overnight as if from nowhere. These fruit bodies arise from the vegetative part of the fungus, which exists as fine thread-like cells called hyphae. The hyphae grow into the food source of the fungus, which may be a rotting tree stump, for example, or decaying organic matter in the soil

Although the hyphae are present throughout the year, usually the only visible evidence of their existence is the fruit body the spore bearing structure also known as the sporocarp. The often bizarre and colourful sporocarps produced by the different species of fungi all have one function in common: the dispersal of the spores over as large an area as possible so that the fungus may colonize new food sources. There are several ways in which the spores can be dispersed and the form of the sporocarp reflects the method used

Using air currents Many species take advantage of air currents to disperse the spores, but they have to overcome the fact that immediately next to the ground is a layer of still air. On a sunny day this layer may be only 1mm thick, whereas on a clear night it can extend up to 10m (30ft) above ground level. Thus the major problem for a fungus using this method is to liberate its spores not into the still layer of air, in which case the spores would just fall back to the ground, but into the turbulent layer above it. Some fungi produce their spores at a height above the ground so that they can be dropped into the turbulent layer, while other species produce their spores close to the ground and 'fire' them up into the turbulent air.

Spore droppers Many of the more familiar mushrooms, bracket fungi and fairy clubs drop their spores directly into the turbulent layer. These fungi are all basidiomycetes; their spores, called basidiospores, are produced on club-shaped cells called basidia. The surface of the sporocarp bearing these basidia is termed the hymenium. The hymenium is elevated into the turbulent layer by means of a stalk (in the case of mushrooms and fairy clubs) or by growing from tree trunks in the



Above: The shaggy ink cap (*Coprinus comatus*) produces its spores on the surface of gills. This species is unusual in that the spore-bearing basidia at the edges of the gills ripen first. Once the spores are released the gill tissue breaks down into an inky liquid which drips away from the cap to expose more basidia. By contrast the earth star (*Geaster triplex*)–see left–bears spores inside its round central body. They are dispersed by the impact of rain drops

case of bracket fungi. The great diversity of fruit bodies among the basidiomycetes is due to alternative methods of producing a large spore-bearing surface (which is needed to create the vast numbers of spores a fungus liberates), packing this surface into a compact form and then placing it in the turbulent zone

A large and important group of fungi in this category are the agarics. They have a fruit body that is generally umbrella-shaped, with a central stalk (called the stipe) supporting a cap, on the underside of which are numerous radially arranged gills. The surface of these gills is lined with the hymenium where the spores are formed

Very similar to the agarics are the boletes Their fruit bodies have the same structure as those of the agarics except that the underside of the cap is covered with thousands of tubes The insides of these tubes are lined with the hymenium, giving the under surface a porous spongy texture

The hedgehog fungus superficially resembles an agaric by having a stalk and cap However, an examination of the sporocarp reveals that the underside of the cap is covered not with gills or tubes but with numerous white to salmon-pink tapering spines. The hymenium covers these spines

Also numbered among the basidiomycetes are the fairy clubs and the bracket fungi. Fairy clubs have no complex cap. Instead the sporocarps consist of upright club-shaped structures, often arranged in groups. The hymenium simply lines the outside of the club Bracket fungi are generally parasitic on trees or saprophytic on dead trunks. Their sporocarps grow out from the trunks or branches of the infected tree, the undersides of the sporocarps being covered with pores through which the spores are released directly into the turbulent layer of the air

Spore shooters Another class of fungi that rely on air currents to disperse their spores–but by shooting them into the air rather than by dropping them–is the ascomycetes. Unlike the basidiomycetes, which bear their spores externally on basidia, the ascomycetes produce spores inside a club-shaped container called an ascus. The ascus typically contains eight spores which are explosively ejected into the atmosphere

The ascomycetes can be divided into several groups, one of which is the discomycetes, so-called because the hymenium (in which lie the asci) lines a cup-shaped or disc-shaped body. An example is the orange peel fungus, which has a bright orange, cup-shaped fruit body. A common feature of the discomycetes is the phenomenon of puffing, the synchronised discharge of mature asci that gives rise to a clearly visible cloud of spores.

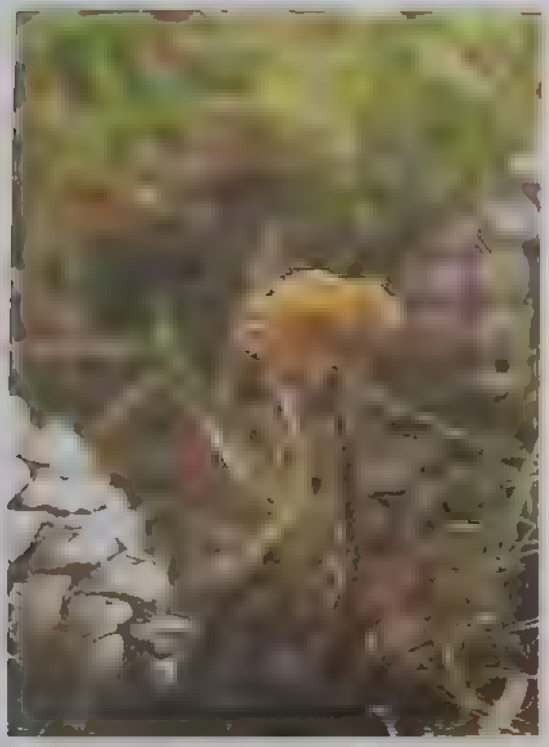
Another group of ascomycetes is the pyrenomycetes or the flask fungi. The asci of these fungi are contained within tiny flask-shaped structures embedded in the flesh of the fruit body. Dead man's fingers is a pyreno-

Above: The spores of a hedgehog fungus (*Hydnum repandum*) are borne on thin tapering spines on the underside of the cap

Opposite page left: The function of a toadstool like sulphur tuft (*Hypholoma fasciculare*) is to raise the spore-producing parts above ground level, though bracket fungi such as this birch polypore (*Piptoporus betulinus*) achieve the same result much more effectively

Right: The spores of a stinkhorn (*Phallus impudicus*) are dispersed by flies attracted by its foetid smell

Below: Dead man's fingers (*Xylaria polymorpha*), one of the pyrenomycetes, fires its spores into the air



Above One of our commonest boletes is the red-cracked bolete (*Boletus chrysenteron*) which grows in association with broad-leaved trees Its cap is dingy brown to pale sepia above with age cracking to reveal coral-red flesh, beneath are the sulphur-yellow tubes through which the spores are released

Left. The ear-pick fungus (*Auriscalpium vulgare*) which grows on buried decaying pine cones, is closely related to the hedgehog fungus and has similar spines on the underside of its cap

Below. A ring of puff balls (*Lycoperdon perlatum*) Inside each is the olive-brown glebal tissue containing the spores

found on beech stumps Its irregularly shaped fruit body is up to 8cm (3in) high and black with a finely wrinkled surface. The flesh is tough and white If one is cut through in cross-section the flask-shaped structures containing the asci can easily be seen just below the surface crust A pyrenomycete with a peculiar fruit body is King Alfred's cakes, which resembles lumps of charcoal stuck to dead beech and ash branches. In cross-section the flesh is marked with concentric silvery-grey and black lines A dry fruit body of this fungus is a good source of fuel when cracked open and ignited it burns fiercely

Dispersal by rain drops Returning to the basidiomycetes, all the ones mentioned so far have their hymenium exposed to the atmosphere. But there is a group of basidiomycetes that have a hidden hymenium - the gasteromycetes. In a gasteromycete the fruit body consists of cavities, the insides of which are lined with the hymenium. The basidia on the surface of the hymenium release their spores into these cavities, and from here they are discharged into the atmosphere by the impact of rain drops on the fruit body

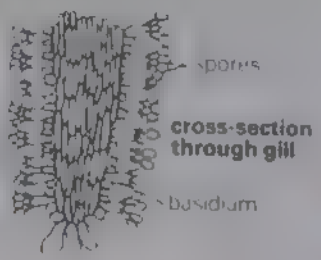
A familiar example of a gasteromycete is the puff ball. The inner tissue of a puff ball (called the gleba) is spongy and contains numerous chambers lined with hymenium. As this glebal tissue breaks down and dries the spores are left as a dusty mass inside the fruit body. When a rain drop strikes the outer surface of the puff ball the surface acts like a bellows, squeezing clouds of spores out through a pore in the top of the puff ball

Dispersal by animals A technique employed by several fungi is to have their spores borne in a material that attracts animals. The animals eat the attractive material and the spores are later expelled, usually some distance away from the parent fruit body. Some fungi that normally use air currents to disperse their spores come into this category–notably the mushrooms that we eat–but there are a few species that rely upon animals as the only means of spore dispersal. The stinkhorns, for example, produce a sickly-smelling slime that attracts flies. As the flies feed upon the slime they ingest the spores contained in it, and so dispersal is effected. Truffles form subterranean fruit bodies that are dug up and eaten by rodents.

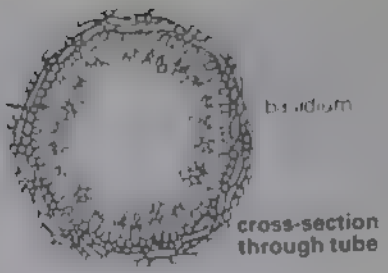
Active dispersal All the methods mentioned so far need an outside agent, but in active discharge the fungus forcibly ejects the spore mass. The most striking example occurs in the fungus *Sphaerobolus stellatus*, a small gasteromycete that forms orange fruit bodies about 2mm in diameter attached to rotten wood and cow and rabbit dung. When mature the fruit body splits open to form an arrangement of two cups, one sitting inside the other and joined only at the edges. The inner cup suddenly turns inside out due to a build-up of pressure and the spore mass inside it is flung out, sometimes over a distance of 4m (13ft)

Methods of spore dispersal

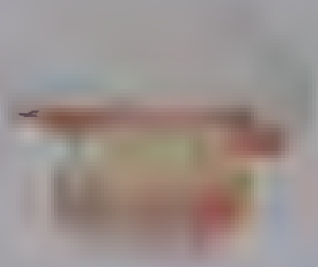
Parasol mushroom
(Lepiota procera)



Spore droppers—gills
The agarics bear their spores in gills on the underside of a stalked cap. The surface of each gill consists of numerous microscopically small structures called basidia, each bearing spores



Spore droppers—tubes
The boletes produce their spores in tubes inside the cap, giving the cap a spongy texture. The spore-bearing basidia line the inner surface of each tube



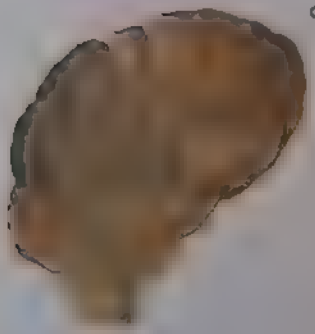
Satan's bolete
(Boletus satanas)

Hedgehog fungus
(Hydnum repandum)

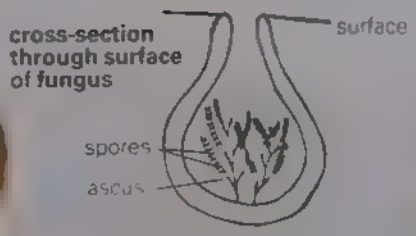
Spore droppers—spines
A few basidiomycetes have a stalked fruit body with the basidia carried, not on gills or in tubes, but on the outer surface of a series of narrow spines that hang from the underside of the cap

Razor strop fungus
(Piptoporus betulinus)

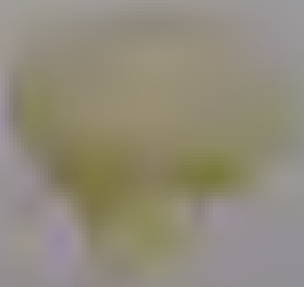
Spore droppers—pores
Bracket fungi lack the stalked fruit body of other basidiomycetes. Instead the fungus gains height by being attached to trees. The basidia are borne in pores on the underside of the body



King Alfred's cakes
(Daldinia concentrica)

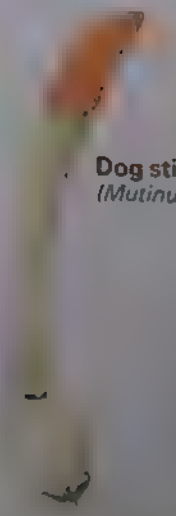


Spore shooters
Ascomycetes have their spores borne inside a club-shaped ascus. In some species the asci are enclosed in a flask embedded in the surface of the fungus. When ripe the spores are fired into the air to be dispersed.

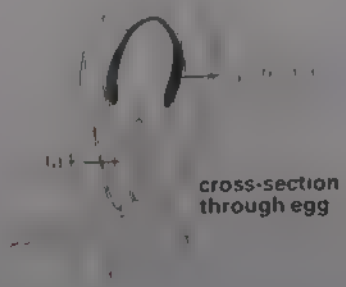


Puff ball
(Lycoperdon pyriforme)

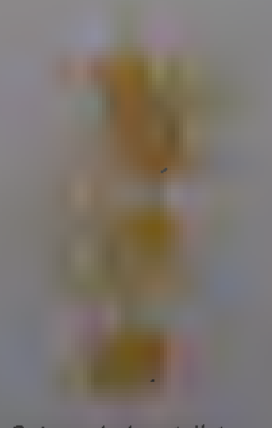
Raindrop dispersal
Puffballs are basidiomycetes in which the basidia line numerous chambers inside the fungal body. As the inside dries out the spores are left as a dusty mass, and when a rain drop hits the body the spores are puffed out through the top.



Dog stinkhorn
(Mutinus caninus)



Animal dispersal
A stinkhorn is initially contained within an egg. When the spores are ripe the stalk expands, bursting through the egg and bearing an evil smelling spore mass on its tip to attract flies



Sphaerobolus stellatus

Active dispersal
In *Sphaerobolus stellatus* the spore mass is borne inside two cups, one fitting in the other and joined only at their edges. As pressure builds up the inner cup is forced to turn inside out, and in so doing forcibly ejects the spore mass

WHITEFRONT FROM THE ARCTIC

Every autumn whitefront geese arrive on our shores to escape the harsh winter of their Arctic breeding grounds, and to graze on our marshes.

The whitefronted goose is a generally grey-brown bird, whose main distinguishing features are a white forehead, a white rump and undertail area, and black bars on its belly Birds in their first year lack both the black barring and the white forehead, though most show some indication of the latter by late in their first winter. Males and females have similar plumage but the former are a little larger

In flight whitefronts appear entirely dark except for the white rump. Their wings are longer and narrower than those of other grey geese and they have a high-pitched laughing call

Different races Whitefronts breed in the Arctic almost right around the globe, from north-west Russia, through Siberia to the Pacific coast, and then in Alaska, Arctic Canada and western Greenland. They winter quite far south, from western Europe, including Britain, around the Black and Caspian Seas, in China and Japan, and in California, Texas and Mexico. Throughout this very large range five different races have been identified: the European, the Greenland, the Pacific, the Interior and the Tule whitefronts

Only two of these, however, are seen in Britain–the European race, which breeds in the western half of Russia and winters in western and southern Europe, and the Greenland race, which breeds in western Greenland and winters in Scotland and Ireland These two species can be distinguished from one another by the colour of their beaks–the European whitefront has a pink beak and the Greenland race a yellow-orange beak–and the generally rather darker plumage of the Greenland whitefront

European whitefront (*Anser albifrons albifrons*) Winter migrant from western Russia to southern Britain Grey-brown plumage with white markings. Pink bill. Length 66-76cm (26-30in)

Greenland whitefront (*Anser albifrons flavirostris*) Winter migrant from Greenland to Scotland and Ireland. Slightly darker grey-brown plumage Orange-yellow bill. Length 66-76cm (26-30in)

Below. A whitefront goose, showing the conspicuous barring on its belly

Winter haunts In north-west Europe, the European whitefront winters in the Netherlands, West Germany, Denmark, Belgium and Britain. Over the last 20 years the numbers in Europe have been increasing very markedly, from about 60,000 in the 1960s to the present 200,000. The great bulk of these have always wintered in the Netherlands, and nearly all this massive increase has taken place there, with numbers in the other countries staying the same or even dropping slightly. It seems that in terms of protection and quantities of food the Netherlands are ideal

In Britain, European whitefronts are found in only a few localities–all in southern England and South Wales. The largest flock (3000–4000) is at Slimbridge on the river Severn near Gloucester. Other flocks, usually numbering some hundreds, occur on the river Towy near Carmarthen, by the river Avon in Hampshire and on the Isle of Sheppey in Kent. There are a few other scattered flocks.

The peak number of whitefronts found in Britain has rarely been above 5000 in recent years, though in the late 1960s it was up to 13,000. The decline has less to do with worsening conditions in Britain, where in fact protection has been improving, than with the excellent conditions the birds find in the

Netherlands.

With the Greenland whitefront, the entire population winters in the British Isles. Its principal haunt is the Wexford Slobs in south-east Ireland. Here some 5000–6000 birds occur, about one third of the total population. Other smaller flocks are scattered over much of central Ireland. In Scotland the main wintering grounds are on the island of Islay in the Inner Hebrides where between 3000 and 4000 birds spend the winter.

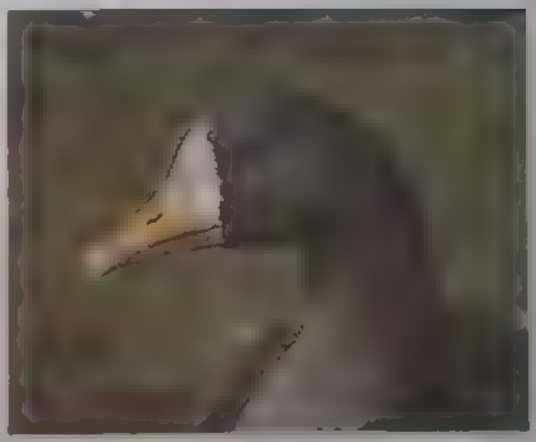
Nests in the tundra Whitefronts nest on the marshy Arctic tundra, making their nests on slight hummocks or mounds, raised just a little above the general level of the surrounding bog. Alternatively, they may nest on dry slopes or banks above pools and rivers. Unlike many Arctic-nesting geese, whitefronts are not colonial but nest apart.

The nest is little more than a shallow depression, around which the female places any pieces of vegetation she can reach, building up a low rim. She lays five or six eggs at daily intervals and then, when the clutch is complete, begins the four-week incubation. After egg-laying she insulates the eggs with down plucked from her breast. She also pulls the down and other nest material over the eggs when she leaves the nest to feed and drink.

Flight to distant lands After the young have hatched both parents look after them, leading them to the best feeding areas. The young birds need to grow as fast as possible, in order to be fully grown before the Arctic winter sets in and they must head southwards. Normally the young can fly about 42 days after hatching, and a few weeks later they set out on their first migration.

The migratory journey south, on which families embark together, may take some weeks, although bad weather can force the birds to move more quickly and cover longer distances. On arriving at the wintering grounds in Europe the family parties remain together in the flock. If you are watching whitefronts feeding, it is quite possible to pick out these family groupings as they move around together within the flock. They return to the Arctic around April, fully replenished for the breeding season ahead.

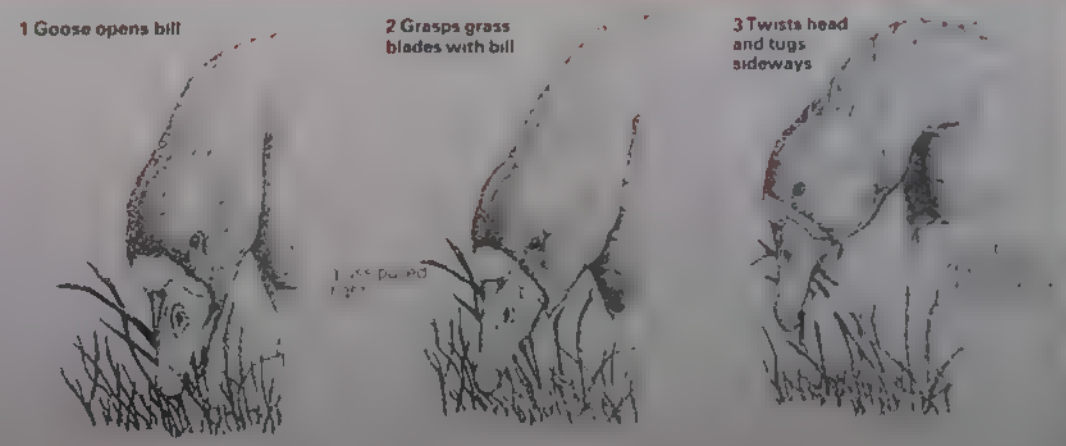
Above: Migrating whitefronts. Many families from the same area combine for the migration, with individual families remaining together in the same flock. In this way the young birds learn the route from their parents.



Right: The distinction between the European and the Greenland race is not always clear. This Greenland whitefront has a pinkish tinge to its bill.

Grazing geese

Whitefronts are entirely vegetarian, feeding on plants in marshy areas and farmland. When grazing they open their bills (1) and seize grass blades with their beaks (2). They then twist their heads and tug sideways (3). The serrated edges on their beaks sever the tightly pulled grass easily. They also probe the ground with their bills for roots and other vegetative matter.



BORAGE AND ITS RELATIVES

The small delicate forget-me-not, the large bushy comfrey and the tall upright viper's bugloss are all members of the same family of plants the borage family, named after a plant which, though not native here, has long been familiar as a garden herb.

The borage family, known to scientists as the Boraginaceae, is a familiar part of the British flora with members occurring in a wide range of habitats from coastal dunes to woodland margins to mountain sides. The family contains some important and well-known medicinal herbs such as comfrey, viper's bugloss and forget-me-not, yet it also includes plants that are not so familiar and with names less pleasing to the ear, such as lungwort and gromwell

About 24 species in the borage family are truly native to the British Isles and many others have become naturalised here. All the British members are herbaceous, being annual, biennial or perennial. Their leaves are nearly always arranged alternately along the stems and in many species are hairy. In viper's bugloss, for example, the leaves and stems [illegible] assume the character of prickles, while the hairs found on hound's-tongue are soft and silky in appearance

Family flowers Blue tends to be the predominant flower colour, although yellow pink and purple are not infrequent. The flowers of many members have the curious characteristic of being pink when in bud but turning blue, or bluish, when they open. This happens in viper's bugloss and forget-me-not, for example

The individual flowers consist of petals that are united to form a five-lobed corolla, which may be flat and round or shaped like a bell or a funnel. Attached to the inside of the corolla are five stamens; in some species these stamens protrude out of the flower. The flowers are usually borne in a compound inflorescence in a shape known as scorpioidal because it looks like the coiled tail of a scorpion

Forget-me-nots As far as Britain is concerned the largest genus in the family is *Myosotis*, the forget-me-nots, with ten British species. Several inhabit wet places, such as stream sides and damp woodlands, though by contrast others are happy growing on dry shallow soils and mountain rocks. The flowers have the blue corollas typical of the borage family.

The name *Myosotis* comes from the Greek for 'mouse ear', a reference to the leaves of the common forget-me-not, which resemble the ears of a mouse in their shape and their soft hairy texture The common forget-me-not is a delightful little plant sometimes seen on cultivated ground, along woodland margins and on sand dunes. The flowers of this annual species are very small, only 5mm in diameter The flowers of the early forget-me-not, however, are even smaller only 2mm across but when the plants are seen massed together as they often are on their favourite sand dune habitat, the over-all effect is quite stunning

Four of our native forget-me-nots prefer wet areas, one of which is the appropriately named water forget-me-not. This is a peren-

Above: One of the rarest members of the family is mountain forget-me-not (*Myosotis alpestris*), which grows at just two sites in the whole country It is a perennial up to 20cm (8in) tall with blue flowers borne on leafy stalks

Right: The plant after which the family is named, borage (*Borago officinalis*) is not native to Britain but was introduced as a culinary and medicinal herb. The conspicuous black structures in each flower are stamens.

nial plant growing to a height of 15-45cm (6-18in), and spreading by means of runners called stolons. This species is unusual in that its flowers have a yellow centre, though the outside has the same blue as the other forget-me-nots

Our rarest member of this genus is the mountain forget-me-not which grows on just two mountains in Britain, one in Cumbria and the other in Perthshire

Native bugloss The remainder of our native species in the borage family are scattered in ones and twos through different genera. For example, the three British plants with the common name of bugloss are shared between two different genera. The plant known simply as bugloss belongs to the genus *Anchusa* and is an upright annual or biennial plant with blue flowers and sharply toothed leaves. It grows in most parts of the British Isles and favours light sandy and chalky soils.

Viper's bugloss and purple viper's bugloss both belong to another genus, *Echium*. Both are biennials found growing on dry, well-drained soils similar to those occurring near our coasts. The common viper's bugloss is a widespread species growing to a height of 90cm (3ft). All parts of the plant are covered with sharp greyish hairs–even its reddish-purple flowers, which eventually turn bluish-purple, have a scattering of hairs

The purple viper's bugloss has a much more restricted distribution, being found only on cliffs and sandy ground near the coast of south-west Britain. This species looks very similar to the common viper's bugloss, though it has much softer hairs and only two stamens protrude from its corolla instead of the four of the common species.

Hound's-tongue The genus *Cynoglossum* contains two native British members–hound's-tongue and green hound's-tongue. The former is the more common of the two; it grows in the same light sandy and chalky soils that bugloss favours. Hound's-tongue (the name comes from the shape and texture of the leaves) is a biennial, growing to about 90cm (3ft) tall. It is one of the exceptions to the rule about members of the borage family having blue flowers: the flowers

Above Flowers and fruits of hound's tongue (*Cynoglossum officinale*) The fruits consist of four flattened nutlets, each covered with bristles surrounding the remains of the style

Above right. Early forget-me-not (*Myosotis ramosissima*) so called because it can flower as early as April

Below Northern shorewort (*Mertensia maritima*), also known as oysterplant growing in Orkney

of this species, and of green hound's-tongue are a dull reddish-purple. Each flower develops into four flattened nutlets surrounded by a thickened border covered with short barbed spines. People with a keen sense of smell may notice that the plant gives off an odour similar to that of mice

Green hound's-tongue is rarer and apparently on the decline. It is a plant of woods and hedgebanks, and differs from the com-

mon hound's-tongue in its leaves, which are greener and only sparsely hairy–those of the common species being covered with long silky hairs–by its smaller flowers and by its nutlets lacking the thickened border

Two comfreys Another genus whose flowers do not conform to the usual blue colour is *Symphytum*–the comfreys, well known for their herbal properties. Five species grow in the wild in Britain but only two, common comfrey and tuberous comfrey, are native Tuberous comfrey rarely grows more than 30cm (1ft) tall and bears yellowish-white flowers. Common comfrey can be much taller up to a height of 1.2m (4ft)–and the colour of its flowers can vary from yellowish-white to pink or purple

Three gromwells The genus *Lithospermum*, the gromwells, is represented in Britain by three native species. The rarest of these is the blue gromwell, which grows in just eight counties of England on chalk and limestone It is a woody-stemmed perennial growing to a height of about 60cm (2ft). Its flowers change colour through the season, beginning reddish-purple and changing to bright blue. They are up to 1.5cm (¾in) across, which is large when compared with the flowers of other native gromwells, the common and the corn, which do not exceed 4mm. The common gromwell is a plant of hedges and scrubland bearing yellowish or greenish-white flowers, while the corn gromwell grows on arable land and has white flowers

Right Common comfrey (*Symphytum officinale*) showing colour variations in its flowers, which can be yellowish-white, pink or purple Comfrey has long been a valuable plant to the herbalist, who uses the leaves and roots for treating sprains, swellings and bruises It can also be employed to treat haemorrhages of the lungs stomach and bowels, and the bleeding of piles

Below: Viper's bugloss (*Echium vulgare*) growing with ragwort on a hillside Four long thin stamens can be seen protruding from the mouths of the flowers, a feature that serves to distinguish this species from the much less common purple viper's bugloss (*E plantagineum*) which has only two stamens protruding from each flower The common name of these plants refers to the belief that they could be used to cure snake bites A drink made from the seeds was also given to cure melancholy

Natives and introductions Among our other native members of the borage family one of the rarer is northern shorewort, or oyster-plant. This low spreading perennial is found on shingle beaches and has remarkably blue leaves. It prefers the coasts of more northerly counties of Britain; in the south of the country it is very rare. Another native species, narrow-leaved lungwort, is an upright perennial plant found in woods and hedgebanks. Its leaves have distinctive white spots and its flowers open pink and then turn deep blue.

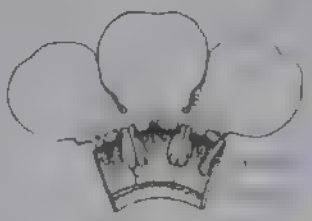
Among the many foreign members of the family introduced to Britain quite a few are now naturalised, including borage itself. Borage is a stout annual species, about 30-60cm (1-2ft) high, and bearing bright blue flowers. A similar-looking species is green alkanet, another member of the family now naturalised in Britain. Occurring in much the same habitat as borage, green alkanet is particularly common in south-west Britain.

Borage was introduced to Britain for its culinary and medicinal uses. Its leaves and flowers have a fragrance similar to that of cucumber and are used for flavouring and garnishing drinks, soups and stews. Herbalists have found borage ideal for treating feverish catarrh; mainly the leaves are used for this Green alkanet seems not to have been used for either cooking or curing It may have been brought here and grown for its red dye

Borages in Britain

1 Common gromwell (*Lithospermum officinale*)
2 Blue gromwell (*L. purpurocaeruleum*)
3 Common forget-me-not (*Myosotis arvensis*)
4 Changing forget-me-not (*M. discolor*)
5 Wood forget-me-not (*M. sylvatica*)
6 Water forget-me-not (*M. scorpioides*)
7 Common comfrey (*Symphytum officinale*)
8 Green alkanet (*Pentaglottis sempervirens*)
9 Narrow-leaved lungwort (*Pulmonaria longifolia*)
10 Common viper's bugloss (*Echium vulgare*)
11 Common bugloss (*Anchusa azurea*)
12 Hound's-tongue (*Cynoglossum officinale*)
13 Northern shorewort (*Mertensia maritima*)

The flowers of all members of the borage family have five stamens attached to the inside of the corolla Shown here is a cut-away of a forget-me-not flower



cut-away of flower

HAVE YOU REALLY SEEN A WILDCAT?

When is a wild cat not a wildcat? Answer–when it is a feral cat. Or possibly when it is a hybrid, that is, when a wildcat has interbred with a domestic or a feral cat. There is still much to learn about the relationship between such cats.

Above: Glen Affric, Inverness-shire in August, a traditional haunt of the Scottish wildcat. This species has expanded its range over the last 60 years, although the population is still far from its pre-20th century levels, and the picture over the last 10-15 years is unclear. A survey of the current population is now under way.

In historic times the European (or Scottish) wildcat was found throughout much of mainland Britain. However, centuries of persecution together with the clearance of forest for fuel, timber and agricultural purposes led to its eventual elimination from England by about 1850, and from Wales by the end of the century. At the same time it was steadily losing ground in Scotland. Although re-afforestation had begun during the 19th century, persecution continued and the wildcat was driven into the remoter areas of north-west Scotland; the population probably reached its lowest level at the beginning of World War I.

Professor James Ritchie, a wildlife expert writing in 1920, was not optimistic about the future of this species in the British Isles, but fortunately his fears were not realised. Many gamekeepers went off to World War I, and since 1918 there have been far fewer employed than at the turn of the century; their efforts have largely been devoted to trying to control the growing fox population. The wildcat quickly responded to this change in the level of persecution, and it began to recolonize areas that it had originally occupied. It continued to expand its range, and surveys reported in 1946 and 1962 both indicated that new ground was being colonized.

The wildcat also suffered severely from persecution in mainland Europe, and it is now a completely protected species in a number of countries. Release programmes which attempt to re-establish this species in suitable areas of its former range in Europe are also in progress.

What is a wildcat? As a species, the wildcat has a wide geographical range, and it is found in Scotland, central, southern and south-eastern Europe, Africa, Israel and eastwards to include north-west India and south Mongolia. The various populations spread over such a wide area have caused taxonomists (taxonomy is the study of classification of animals or plants into groups) many problems over the years. Many cats collected in Asia and Africa were thought to be separate

species and the classification of wildcat became confused

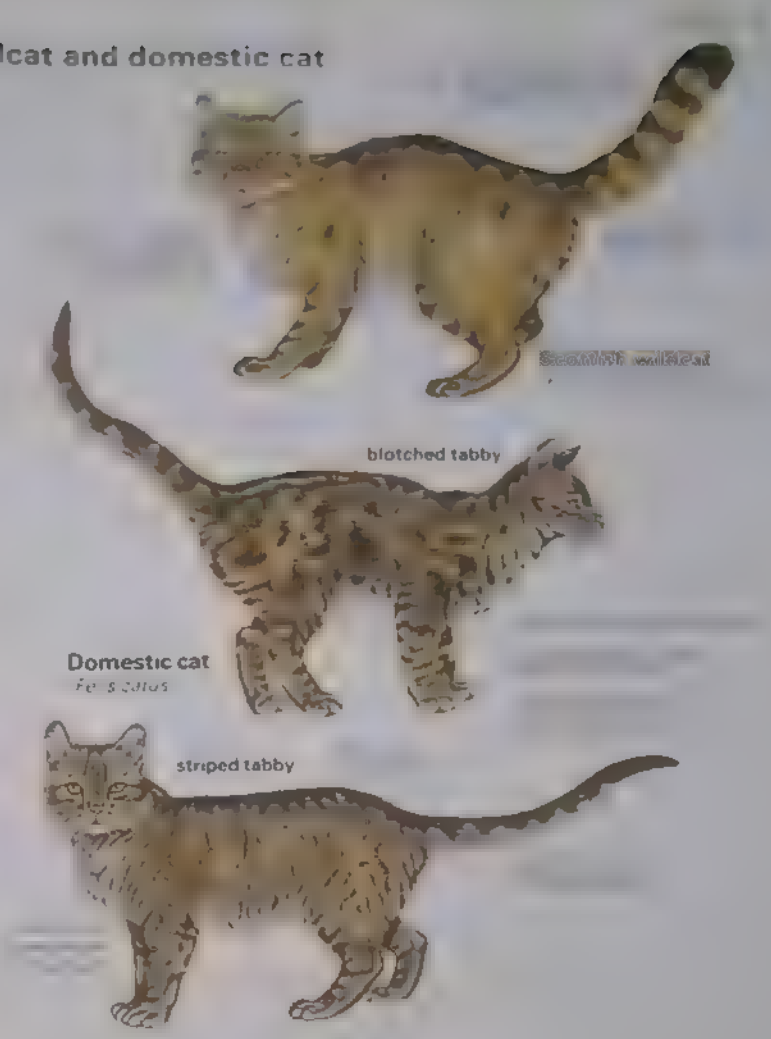
However, after further study and d liberation the taxonomists realised that man of the cats were so similar to the Europea wildcat that they could not be considered a different species, and they were subsequently classified as sub species

There are now thought to be three major groups of wildcats: European *Felis silvestris silvestris*; African *Felis silvestris lybica*; and Asiatic *Felis silvestris ornata*. The wildcats found in Scotland are obviously part of the European group, and have been renamed *Felis silvestris grampia* - so distinguishing them from the central European form because of their more pronounced markings and darker general colour. However, within the British population there is variation in the colour and intensity of markings, and it is perhaps debatable if the taxonomic distinction is justifiable

Wildcats and domestic cats Wildcats and domestic cats are quite closely related. It is now thought that the domestic cat is descended from the African wildcat, the kittens of which are said to make quite docile pets, in marked contrast to those of the European wildcat, which are rarely tamed

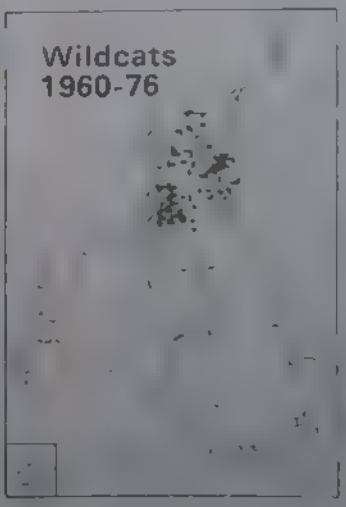
No one really knows for certain when domestication actually started, but it was probably about 4-5000 years ago. The Egyptians are known to have kept cats from about 2000BC, and the mummified remains of cats from that period have been found to be similar to the African wildcat. The practice of keeping cats, probably for the control of rats and mice, spread throughout the Middle East and it was the Romans who introduced the cat to Europe

It was probably inevitable that some interbreeding occurred between the resident wildcats of Europe and the introduced cats: Europe was, of course, a much wilder country in the first century AD than it is today. The progress of cats across Europe seems to have been rather slow, and they were uncommon in England until the 10th century. Today's



Above. A wildcat and a blotched and a striped tabby However they may appear, all domestic and feral cats are genetically tabbies, their tremendous variety of colours is simply the result of careful breeding over generations Even the purest white cat is a tabby beneath the surface

Left: A wildcat at the Highland Wildlife Park in Inverness-shire and (below) a map showing the population from 1960-76



Left Three stray tabbies and (right) a rare photograph of a hybrid probably the result of a mating between a male wildcat and a female feral or domestic cat

Wildcat habitat

Wildcats live in a variety of habitats in Scotland, ranging from high moorlands and mountainous areas to pastures. However, they are usually found below 500m (1650ft) and their preferred habitats are deciduous and coniferous woodland and scrub, especially near areas of pasture and moorland where rabbits and small mammals are found. They are also found on open moorland, but when bad weather arrives in winter they seek shelter in any available woodlands. Forest plantations provide valuable food and shelter, which has helped the spread of this species. Wildcats also live in the Highland Wildlife Park.

domestic cats, although not descended directly from the European wildcat, have probably been influenced by inter-breeding in the past

Feral cats The domesticated *Felis catus* still retains a great deal of independence and is quite capable of fending for itself. Domestic cats living a free existence are often, incorrectly, referred to as 'wild cats', which causes confusion with the genuine wildcat. These cats of domestic origin are correctly termed feral cats, and there are populations of these animals in most of our large cities as well as in the country

A tabby coat is the 'wild-type' and its camouflaging effect is important for the survival of the cat in the wild. Feral cats often revert to this coloration over several generations and it is then, in particular, that these animals are mistaken for real wildcats. Feral cats are also found throughout Scotland and, although they tend to occupy areas around human habitation, exploiting whatever food is available, they can turn up in remote areas, miles from the nearest house or village. So even in northern Scotland the appearance of a tabby coloured cat on a moorland road at night, in a car's headlights, is no guarantee that it is a wildcat.

Tabbies and wildcats What, then, are the differences between the wildcat and the domestic cat? The problem naturally is to distinguish tabbies and wildcats. Wildcats are usually about a third larger and more heavily built than domestic cats. The average weight of male Scottish wildcats is 4.7kg (10½lb), while females weigh 3kg (8½lb), and although very large animals may reach 7.25kg (16lb), exceptional domestic cats can weigh as much as 9kg (20lb). Size alone is not therefore a reliable distinguishing feature.

It can also be difficult to distinguish these cats on the basis of their colour and markings. The coat of the wildcat is grey or yellowish-brown with about eight to eleven dark body stripes. Domestic or feral tabbies may be similar in colour and can have a blotched or striped coat; however the latter form generally has more stripes than the wildcat. White patches are common on domestic tabbies, particularly on the feet, which is not the case with wildcats. The best distinguishing feature, however, is the tail, which in the wildcat is about half the combined head and body length or less, and appears short and club-like because of its thick fur. It has up to five black rings completely encircling it, and terminates in a blunt black tip. In contrast the domestic tabby's tail appears to be relatively longer, and it is slimmer and tapers to a point; rings

Below: Wildcat kittens in their den. They are usually born in deep forest but they are soon moved to various temporary dens, often in more exposed parts of the countryside

are less distinct and are often fused together

Cat hybrids The possibilities of wildcats inter-breeding with domestic or feral cats in the past have already been mentioned, and there has been much speculation about its occurrence in more recent times. Some people believe that such inter-breeding did not happen, or if it did, that the offspring were infertile and hence there was no threat to the wildcat population in Scotland. Others considered that there were no 'real' wildcats left in Scotland, a consequence of a long history of inter-breeding with domestic cats

It probably comes as no surprise to learn that domestic cats and wildcats can be successfully crossbred in captivity and produce fertile offspring. But does this happen in the wild? The answer is yes, but it is not known to what extent. It has been said that it is invariably the male wildcat which mates with the domestic female, but hybrid kittens are more likely to be noticed if born to a domestic cat than if a female wildcat is the mother Nevertheless, there may be some truth in this suggestion: young male wildcats wander furthest from their place of birth, and it is this group which probably colonizes new ground On entering a new area they may be obliged to mate with any female cat available, including domestic or feral animals. Resident male wildcats may visit any domestic females on heat in the vicinity, while proving to be formidable opponents to any domestic or feral toms with an interest in female wildcats in the mating season

Little is known about the hybrids since few have been authenticated, but from those produced in captivity or as a result of the known crossing of a wildcat and domestic cat, the hybrid usually has the overall coat colouring and markings of a wildcat, but the tail resembles that of the domestic cat. The tail rings, as in the domestic cat, are usually less distinct, fused together or joined along the dorsal surface. Because of the apparent similarity between wildcats and hybrids, attempts have been made to distinguish these animals more precisely. An approach which shows promise involves taking measurements of the skull, and dead cats (for example, road casualties) are being examined from different parts of Scotland. It may be possible in due course to suggest how much hybridisation is occurring in Scotland

Looking for wildcats A survey is under way of the rarer British carnivores, including the otter, pine marten, wildcat and polecat. In the case of the wildcat we know that there has been an expansion of range over the last 60 years, but the picture during the last 10-15 years is unclear. Has the range of this species continued to expand, and if so to what extent, or has ground been lost?

Searching the countryside is difficult. The wildcat is shy and mostly active at dusk, dawn and at night. The chances of seeing one even where they are known to occur, are therefore slim. Unfortunately, there is really no way of distinguishing, by their tracks or droppings, domestic/feral cat signs and those of the wildcat, so such methods are of limited value. There is also a large area of potential habitat for this species in Scotland. Information is welcome from gamekeepers, foresters, landowners and naturalists who are likely to come across wildcats. Areas of expected wildcat range are then checked

Above. A portrait of a Scottish wildcat in its normal, relaxed posture and (below) a wildcat in captivity. Should the wildcat become established south of Glasgow and Edinburgh, there is an abundance of suitable habitat available In time it may even colonize the north of England

DASHING DACE OF FAST WATERS

One of our smallest, sleekest members of the carp family, the dace is also among our most successful freshwater fishes. On a summer's day you may see one leaping out of a river, eager to catch any insect that has strayed too close to the water.

Above: A young dace. The dace, and its close relatives the chub and the ide, are river fishes but the dace differs from the other two in that the chub and the ide will live in still waters, and indeed are common in lakes, whereas the dace cannot live in such waters. If released into a lake it would not thrive there, and it certainly would not breed

Dace are widely distributed in rivers across England, and in central Wales in the Dee catchment. Dace have also been reported on the borderlands of Scotland, though they were undoubtedly introduced there, and they also occur sparsely in the south of Ireland, being found in the River Blackwater in County Cork – again as an introduction

The fresh waters of northern Europe are dominated by fishes of the carp family. Most are slender bodied with modest-sized scales on the body but not on the head. They have a single dorsal fin, which contains no sharp spines, and a slightly forked tail. Cyprinids live in schools, actively swimming in search of food or shelter. The dace is in many ways a typical member of the family, for it is an active schooling fish that lives mainly in open water in rivers.

Distinguishing the dace Its closest relatives in British waters are the chub and the ide or orfe, an introduced fish often seen in its golden-coloured ornamental form. The dace is rather more slender than either of the other two and has a narrow pointed head. Its scales are moderately small, with between 48 and 51 scales in the lateral line. Both chub and ide have broad heads and heavy muscular backs, and different numbers of scales along the lateral line, chub having 44 to 46 scales (which are thus larger than in a dace of comparable size) and the ide having 56 to 61 much smaller scales

The most important distinguishing feature, however, is the shape of the outer edge of the anal fin (and to a lesser extent of the dorsal fin) In the dace it is concave, while the chub has a distinctly convex or rounded free edge to the fin. The ide has a flat dorsal fin and a slightly concave anal fin

All these features are the kind of characters that can be used to distinguish a fish in the hand. It is much more difficult to be sure about the identity of fish in the river However, if you see a small school of fishes in a river in shallow water, swimming rapidly and keeping close formation, then the chances are that they are dace. The presence of the school may be betrayed by the quick gleam of silver as light catches the side of a fish turning, but the flash is always brilliantly silver with none of the golden glint or the spark of red fins that comes from a school of roach

Where to look Dace are essentially river fish Small specimens up to 13cm (5in) long live in small streams (sometimes almost narrow enough to jump across). Typically they are brooks with wider shallow stretches interspersed with deeper pools at the bends in the stream. In upland areas small dace can be found where rocks narrow the beck into a series of pools and small torrents.

These little waters are important nursery streams for the dace, which share this habitat with juvenile trout and grayling, and young minnows. However, young dace are not confined to such tiny streams. At a length of 20-25cm (8-10in) they dominate the smaller clean rivers where the flow is moderate, and fishes of this length and up to their maximum size of 30cm (12in) live in large rivers. Dace are now one of the most abundant freshwater fishes of the upper tidal Thames and very large numbers are caught by anglers there This shows, in addition to the cleanliness of the

river today, that dace thrive in a large river, even one with heavily silted water like the Thames, provided there is a continuous flow of water.

Spawning time The dace spawns earlier in the year than do most members of the carp family. The precise date varies with the local climate and the severity of the weather, but it usually takes place when the water temperature reaches about 7-8 C (45-46 F). In rivers in southern England this means that spawning usually begins in the second half of March, but in the north it may not take place until early April. A very cold winter or a cool cloudy spring may delay the spawning.

Spawning occurs mostly at night, the schools gathering in gravelly shallows at the 'tail' of a riffle where the water runs quickly over a stony bed. The eggs are yellowish and about 1.5mm in diameter. Being slightly sticky when first laid they adhere to the fine mat of algae covering the gravel, or they fall between the stones themselves. As the water temperature is relatively low when the eggs are laid, development is slow and in a normal spring they do not hatch for between 25 and 28 days.

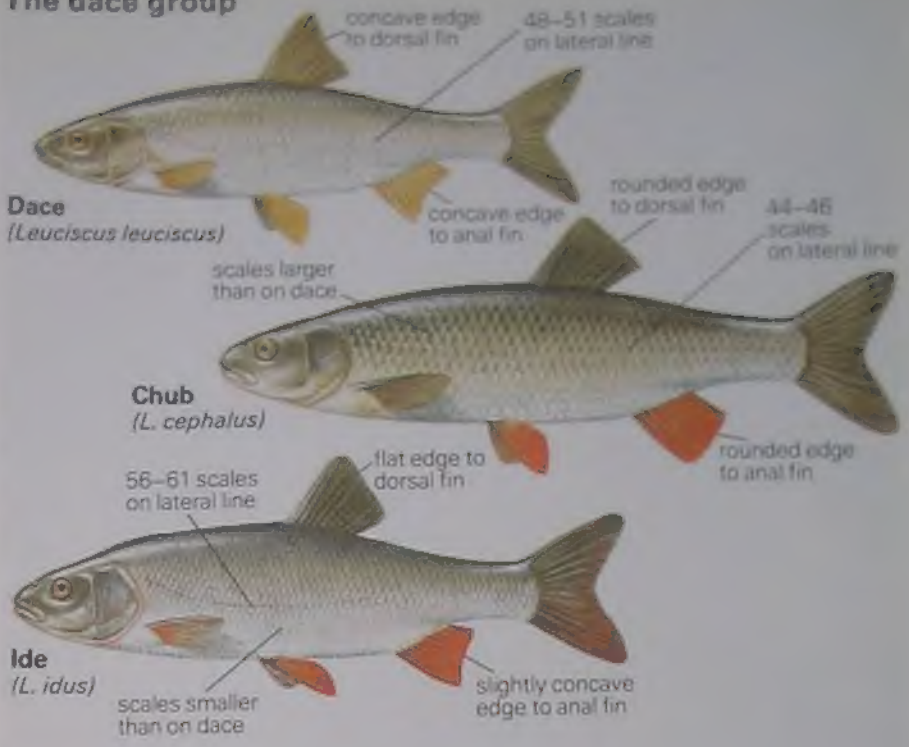
The number of eggs produced by the female varies with her size (as it does in all fishes). Females about 15cm (6in) long–the length at which they begin spawning–produce around 3000 eggs, while those of 25cm (10in) may shed as many as 18,000.

Success story Despite the low number of eggs laid and their long period of lying unprotected on the river-bed, the sheer numbers of dace in our rivers show them to be a very successful species. This is probably due to their spawning much earlier than any of their carp family relatives and in a different part of the river (most of their relatives spawning in deeper water). This means that as soon as the water begins to warm up in the spring and the populations of crustaceans and other invertebrates begin to build up, the young dace are in a favourable position to take advantage of this food. But they are often on a knife-edge: a late spring, or heavy rains followed by frosts, might mean that as much as 90% of the young dace die within a week of hatching.

The diet of the adults is relatively unspecialised except that they eat large numbers of insect larvae. In winter they tend to feed on caddis-fly larvae and even molluscs, but in summer they eat mayfly larvae and adults, blackfly and midge larvae, and a very small proportion of algae and water plants.

During the summer dace are at their most visible, leaping at the surface of the water in pursuit of newly hatched mayflies or caddis flies, and ever on the lookout for the hatching of aquatic insects. Anglers take advantage of the dace's surface-feeding activities by fishing for it with a fly and are frequently successful for, although the dace is rather a small fish, it gives good sport on a fly rod.

The dace group



Above: The dace and its close relatives are best distinguished by the shape of the edge of their anal and dorsal fins. The colour of the lower fins may vary from yellow to orange in both dace and chub, and is reddish in the case of ide.

Right: In summer dace leap out of the water in pursuit of food.

Below: The dace has a very acute sense of smell, aided by the nostrils in front of its eyes.

Rising to feed

WATCHING INSECTS

Amateur naturalists are often deterred from doing their own research in the belief that all has been discovered. Nothing could be less true–especially with insects.

Above: A young amateur naturalist watching a southern aeshna dragonfly emerging from its nymphal case.

Below: Surprisingly, much research still remains to be done on the easily recognisable insects. For instance, our knowledge of the common bee-fly and the flowers which it visits for nectar is still fragmentary so an interesting project might be to record all the flower species which it visits in your garden.

The basis of natural history study is field observation. Therein lies the attraction: the satisfaction derived from watching the activities of wild animals in usually agreeable, open-air surroundings while adding to our knowledge.

The immense number of professional and senior amateur research workers, and the vast literature on entomology, tends to foster the impression that nothing remains to be discovered. In fact, with around 20,000 known British insect species and others being discovered regularly, there is a great deal of satisfying research that the ordinary amateur can undertake, even with limited spare time. For instance, even some of the commonest British butterflies and moths, let alone the rarer ones and the other less popular groups of insects, have yet to be fully studied.

Where to start All you need to begin with is sufficient enthusiasm and curiosity about insects you see to start asking yourself questions about what they are doing, and how and why. Naturally, this leads you to try to find the answers in books, and then you may discover the gaps in the common fund of knowledge plus the fundamental errors that are repeated by authors time and time again.

You can obtain a head start by joining your local natural history society or a national entomological society. Through them you will make contact with experienced entomologists from whom you will learn the necessary techniques.

Most people start out by noting the species they have seen in their neighbourhood, and then submitting their records for publication in the local society's publications. Later on you may publish a paper of your own, for example on the butterflies or dragonflies you have recorded over a period of years in a locality which you visit regularly–this is not that easy though.

Sooner or later you may wish to progress by enquiring into the lives and the behaviour of these insects as well as, or instead of, merely recording their local distribution. Much can be accomplished by the amateur simply through pure observation, although later you may wish to test certain conclusions by carrying out simple experiments.

Obviously, the first thing to do is to decide which line of enquiry interests you most and concentrate on that. Of course, you may find that you can handle two or three different investigations quite comfortably, but the important thing is not to attempt too much and thus lessen the time you have available for field observation on each project. Here are a few suggested lines of enquiry you could follow.

Insect pollination There is much you can do without too much effort. Your garden would be an ideal place to start as you can put in more field hours there than in localities which involve travel. And what better place to

choose, for instance, to undertake a study of insect pollinators?

While it is not too difficult to identify accurately all the butterflies and many of the moths and hoverflies which seek nectar from flowers, it is a different matter when it comes to the lesser known insect groups, such as the ichneumon wasps, where identification can be a real problem. If you have joined a local natural history society you may well receive help in identification from the specialists in the society. Entomology could certainly benefit from additions to the rather thin ranks of those who are knowledgeable about Diptera, Hemiptera, Hymenoptera and Orthoptera. Many discoveries await the entomologist who does so, including the possibility of adding new species to the British list.

However, even if you are unable to identify the more difficult insect flower visitors, it would still be useful to record them provided you can at least learn to recognise the family to which they belong.

Watching flower visitors If you wish to attempt a comprehensive study of the insects visiting wild and cultivated flowers in your garden, or some other site such as a park, then it is valuable to record the comparative abundance of the different species of insects on the various plants.

On the other hand, if this seems rather demanding, then concentrate on recording the insect visitors to a particular species of plant. Members of the umbellifer plant family are fascinating to study as they attract large numbers of insects.

Some of the common alien plants growing in waste places all over Britain would also reward study of this kind. As well as recording the insects which feed at their flowers, it would be very interesting to know which insects feed on their foliage, either in the adult or larval stages.

When recording flower visitors you should also investigate their methods of obtaining the nectar, looking particularly for any special structural adaptations which enable them to exploit particular plant nectaries efficiently, and whether or not they carry away pollen.

Above: In summer, hogweed flowers are crowded with many varying insect species – in this case soldier beetles, flies and a wasp. A detailed investigation of the fauna on this plant would be well worthwhile.

Right: Grasshoppers are easy to watch as they take little notice of quiet human observers.

Below: The courtship and mating behaviour of such butterflies as common blues is always fascinating.

How many flowers on a particular plant do they visit? Do they specialise in a single species, or a family of plants? All these questions are absorbing ones to try and answer.

Studying flower visitors at dusk or during the night with the aid of a torch is also very worthwhile. There is much to be discovered about the flower preferences of moths and other nocturnal insects. For example, we know a fair amount about those visited by the hawkmoths, but not nearly as much about the less conspicuous noctuids.

Behavioural studies There is great satisfaction in watching the undisturbed activities of insects, in much the same way as people watch birds. And the same techniques can be used. Of course you do not need a hide; as long as you sit or stand still insects take little notice of you. Binoculars can be useful, especially for watching butterflies or other large, day-flying insects. Look out for, and describe in your notebook (or verbally in a cassette recorder), any interesting behaviour.

Much remains to be learnt about the territorial behaviour of butterflies, dragonflies grasshoppers and many other kinds of insects. Do they warn each other or potential predators with recognizable threat displays as birds do? We know that many distasteful insects, such as burnet and cinnabar moths, have bright warning colour patterns which deter attacks from birds and other predators.

Above: A good way of watching butterflies, like this small copper, at a distance is to use binoculars. You could also see such details as the long proboscis of a hummingbird hawkmoth (below) when the moth is feeding.

Attacks on them must nevertheless be made from time to time by inexperienced birds, but field observations of these are rare.

More advanced research For those wanting to embark on some more complex research projects, here are a few ideas. Comparatively few people have studied grasshoppers and crickets, and in particular there is little precise information on their food preferences. Some bush crickets are known to change their diet in the course of their development, like the speckled bush cricket which switches from feeding on herbs in its early stages to the leaves of broad-leaved trees when adult. Other species become more carnivorous as they grow older, but detailed studies are wanting.

Some of our commonest grasshoppers, such as the common field grasshopper and the mottled grasshopper, occur in different colour forms (polymorphism) and there is plenty of scope for relating the relative frequency of each to the environmental conditions prevailing. Here is something more the keen amateur could undertake. There is certainly no end to the possibilities for the research-minded.

Nature sketches

When observing insects in the field sketches are invaluable–but they must be accompanied by notes. Here a naturalist has recorded the behaviour of two adult green hairstreaks: one at rest with its wings closed and another drinking from a raindrop on a gorse flower. The other sketch shows the position of this species' eggs on a plant.